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Oral health problems in leukaemic paediatric patients in the United Arab Emirates: a retrospective study

ABSTRACT

Aim *The aim of this study was to estimate the prevalence of oral health problems in leukaemic paediatric patients in the United Arab Emirates (UAE) and correlate it to the phase of chemotherapy.*

Materials and Methods *Medical records of 120 paediatric leukaemic patients (age below 15 years) in the UAE were reviewed for the occurrence of oral health problems. Records from the three main hospitals that provide cancer therapy were accessed after obtaining the required permissions.*

Results *The overall prevalence of oral health problems in leukaemic patients in our study is 60%. The most common oral health problem recorded in the patients' records was oral mucositis and ulceration (52.4%) followed by dental caries and oral candidiasis accounting for 18.3% and 14.2% respectively. Other oral health problems recorded were gingivitis and gingival bleeding, herpetic gingivostomatitis, poor oral hygiene, and facial palsy. The peak occurrence of most oral problems was during phase IV (maintenance). Oral health problems were more common among patients who received treatment and follow-up locally rather than abroad. Statistics: Collected data were analysed using statistical software International Business Machines (IBM) Statistical Package for Social Sciences (SPSS, version 20, Chicago, SPSS Inc). Descriptive statistics were performed to describe the characteristics of the study population. The association between oral health problems and other risk factors was analysed using the Chi-squared test. A P-value of <0.05 was considered statistically significant.*

Conclusion *This is the first study to describe oral health problems and its correlation to the phase of chemotherapy in leukaemic paediatric patients in the UAE. Oral health problems as a result of leukaemia and its management are both variable and unavoidable. Therefore, oral and dental care is of critical importance in maintaining the overall wellbeing of the patient before, during, and after treatment. This can be achieved by close liaison between the oncology and dental teams.*

Keywords *Chemotherapy, Children, Leukaemia, Mucositis, Oral health, United Arab Emirates*

Introduction

Haematopoietic malignancies are blood cancers defined as clonal diseases derived from a single bone marrow cell or from peripheral lymphoid cells that have undergone genetic alteration [Hoffbrand and Moss, 2011]. The most common type of haematopoietic malignancy in children is leukaemia [Pui, 2006]. In the UAE, leukaemia accounts for almost 46% of all cancers affecting children [El-Hayek et al., 2003]. In broad terms, leukaemias are classified as acute versus chronic and as lymphoid versus myeloid. The terms acute and chronic describe the relative durations of survival of patients with these diseases before effective therapy was available. With improvements in treatment, they have taken on new meanings [Hallet et al., 2013]. The terms myeloid and lymphoid refer to precursor blast cells that are involved having reduced capacity for further differentiation into mature cellular elements [Pui, 2012].

Treatment modalities for leukaemia include chemotherapy, radiotherapy, with or without haematopoietic stem cell transplantation (HSCT). An incidence of overall oral and dental health problems of 90% in patients receiving cancer therapy has been reported in the literature [Kumar et al., 2013]. Examples of these effects are oral mucositis and ulceration, infections of fungal and viral origins, salivary gland hypofunction and xerostomia (dry mouth), dental caries, hypoplasia and aplasia of permanent dentition, and others [Bertl and Stavropoulos, 2017; Pui, 2006]. The most common oral manifestation is mucositis and oral ulceration followed by fungal and viral infections respectively [Pui, 2006]. Oral and dental infections may complicate the course of

cancer therapy [Da Fonesca, 2013]. These infections can also affect the oral health-related quality of life (H-RQL) of these children [Wong et al., 2012].

The dental team plays a pivotal role in performing the initial assessment of the oral health status of the patient. It also defines the basic oral health needs before, during, and after cancer therapy [Kumar et al., 2013]. Dental consultation on recently diagnosed children is highly recommended in order to ensure sufficient time for the appropriate dental care to be provided before the initiation of cancer therapy [Da Fonseca, 2013]. This can help minimise oral and dental complications especially during the course of treatment. A multidisciplinary approach is essential between the medical and the dental teams to help prevent, stabilise, and manage the oral and dental sequelae at an early stage [Kumar et al., 2013; Hosey and Welbury, 2012].

The oral health problems in leukaemic children in the UAE have not been studied previously. Therefore, objectives of this retrospective study were to describe the pattern of oral health problems associated with cancer therapy in leukaemic paediatric patients with in the UAE, and correlate it to the phase of chemotherapy.

Materials and methods

This retrospective (historic) study was designed to describe the pattern of oral health problems in paediatric patients diagnosed with leukaemia in the UAE and correlate it to the phase of chemotherapy.

Medical records (paper and electronic) of paediatric patients (below 15 years as defined by the World Health Organization) who had been diagnosed and treated for leukaemia in the following hospitals were reviewed by the author for any oral and dental problems before, during, and after cancer therapy: Sheikh Khalifah Medical City (SKMC) in Abu Dhabi, Tawam Hospital in Al Ain, and Dubai Hospital in Dubai. The review covered a 10-year period from 2003 until 2013. The study was a multi-centre study involving data being collected from all aforementioned governmental hospitals in the UAE that had paediatric oncology/haematology departments.

An inclusion criterion was the availability of complete medical records including the following variables: hospital, age, gender, date of birth, nationality, diagnosis (new and recurrent cases), date of diagnosis, and family history (history of cancer, history of other disease, history of both). A total of 155 medical records were reviewed, out of which 120 records were included and 35 incomplete medical records were excluded. A total of 75 patients received the treatment and follow-up within the UAE hospitals while 33 patients received the cancer treatment and follow up both abroad and in local hospitals. Only 12 patients were diagnosed locally and travelled abroad for treatment. They had follow up visits in the UAE. A pilot study was conducted to check the feasibility of the data collection sheet. A total of 10 medical records were piloted in SKMC and Dubai Hospital (five each). Modifications were made to facilitate the process of data collection. The variables that were included in the data collection sheet were the name of the hospital, patient's initials, file number, gender, date of birth, nationality, diagnosis, date of diagnosis, family history, and the description of oral health problems at different stages of treatment. Collected data were analysed using statistical software International Business Machines (IBM) Statistical Package for Social Sciences (SPSS, version 20, Chicago, SPSS Inc). Data were entered using specific values for each variable. Values for oral health problems were regarded as "1" for the presence of at least one incidence of the oral health problem and "0" for no cases reported. Descriptive statistics were performed to describe the characteristics of the study population. The association between oral health problems and other risk factors was analysed using the Chi-squared test. A P-value of <0.05 was considered statistically significant.

Results

Characteristics of the Study Sample

From 155 medical records of paediatric leukaemic patients, 120 met our study criteria (35 were incomplete and were excluded). Out of the 120 clinical records, 64 were digital from SKMC and Tawam hospitals whereas 56 were paper-based from Dubai hospital. The distribution of the selected records that met the inclusion criteria in each hospital was as follows: 20 (16.7%) digital records from SKMC, 44 (36.75%) digital records from Tawam Hospital, and 56 (46.7%) paper-based records from Dubai Hospital. The distribution of the number of paediatric leukaemic patients per hospital are summarised in Table 1.

The oral health problems were reported from 72 (60%) of the patients (Table 2). No association was found between age, gender, nationality, or family history and the abnormalities of oral health. However, there was an association between oral manifestations and the treatment centre, since oral manifestations were more among patients who received treatment locally. This was represented by a total number of 54 (75%) patients with oral manifestations receiving cancer therapy locally compared with 21 (43.8%) patients without oral manifestations. Only 2 (2.8%) patients who were treated abroad had oral manifestation documented during follow up visits in the UAE compared to 10 (20.8%) patients. In total, 17 (35%) children who received treatment and follow up abroad and locally did not encounter any oral health problems compared to 16 (22.2%) who had documented oral health problems. The difference in the occurrence of oral manifestations between the children who received the treatment locally versus the ones receiving treatment abroad was statistically significant (P-value <0.001). The prevalence of all oral health

Characteristics	Number (%)
Hospital	
SKMC	20 (16.6)
Tawam Hospital	44 (36.7)
Dubai Hospital	56 (46.7)
Age	
Minimum	<1 year
Maximum	14.9 years
Mean	4.67 years
Gender	
Male	68 (56.7)
Female	52 (43.3)
Nationality	
UAE	44 (36.7)
Others	76 (63.3)
Diagnosis	
ALL	86 (71.7)
ALL with relapse	15 (12.5)
ALL with other disease	8 (6.7)
ALL with other disease & relapse	1 (0.8)
AML	3 (2.5)
AML with relapse	6 (5)
CML	1 (0.8)
Family history	
Normal	76 (63.3)
Positive with other disease	28 (23.3)
Positive at least with cancer	16 (13.4)
Treatment Centre	
Local	75 (62.5)
Abroad	12 (10)
Both	33 (27.5)
Oral Findings	
Negative	48 (40)
Positive	72 (60)

TABLE 1 Demographic and clinical characteristics of the study sample.

		Oral Health Problems		P-value
		With (%)	Without (%)	
		72 (60)	48 (40)	N/A
Age	Mean (SD)	4.48 (2.64)	4.89 (3.33)	0.455
Gender	Male	37 (51.4)	31 (64.6)	0.107
	Female	35 (48.6)	17 (35.4)	
Nationality	UAE	27 (37.5)	17 (35.4)	0.486
	Others	45 (62.5)	31 (64.6)	
Family history	Normal	41 (56.9)	35 (72.9)	0.148
	Other disease	21 (29.2)	7 (14.6)	
	Cancer	10 (13.9)	6 (12.5)	
Treatment centre	Local	54 (75)	21 (43.8)	<0.001
	Abroad	2 (2.8)	10 (20.8)	
	Both	16 (22.2)	17 (35.4)	

TABLE 2 Comparison of characteristics between groups with and without oral health problems.

problems recorded in paediatric leukaemic patients is shown in Figure 1. The prevalence according to each stage of treatment is summarised in Table 3. The different stages of treatment were as follows.

- Before initiation of cancer therapy.
- During cancer therapy:
  - Phase I (induction);
  - Phase II (consolidation);
  - Phase III (delayed intensification);
  - Phase IV (maintenance).
- Post-treatment (disease-free).
- Relapse cases.
- Un-specified (treatment phase is unclear).

Oral mucositis and ulceration

The occurrence of mucositis increased with time under treatment (Table 3). It was not reported during phase I. In phase II, 7 cases (5.8%) were reported while only one

Oral health problem	Phase I	Phase II	Phase III	Phase IV	Post-treatment	Relapse	Un-specified	Total
Oral mucositis & ulceration		7 (5.8)	1 (0.8)	12 (10)	3 (2.5)	7 (5.8)	33 (27.5)	63 (52.4)
Candidiasis		2 (1.7)	1 (0.8)	4 (3.3)	2 (1.7)		8 (6.7)	17 (14.2)
Herpes and herpetic gingivo-stomatitis		1 (0.8)	1 (0.8)	5 (4.2)	1 (0.8)	1 (0.8)	2 (1.7)	11 (9.1)
Gingival bleeding				2 (1.7)		1 (0.8)	2 (1.7)	5 (4.2)
Gingivitis				1 (0.8)	3 (2.5)	1 (0.8)		5 (4.1)
Oral petechiae							2 (1.7)	2 (1.7)
Dental caries		1 (0.8)		5 (4.2)	6 (5)		10 (8.3)	22 (18.3)
Poor oral hygiene					1 (0.8)		4 (3.3)	5 (4.1)
Facial pain/palsy							2 (1.7)	2 (1.7)
Other					2 (1.7)			2 (1.7)

TABLE 3 Prevalence of recorded oral health problems according to treatment phase.

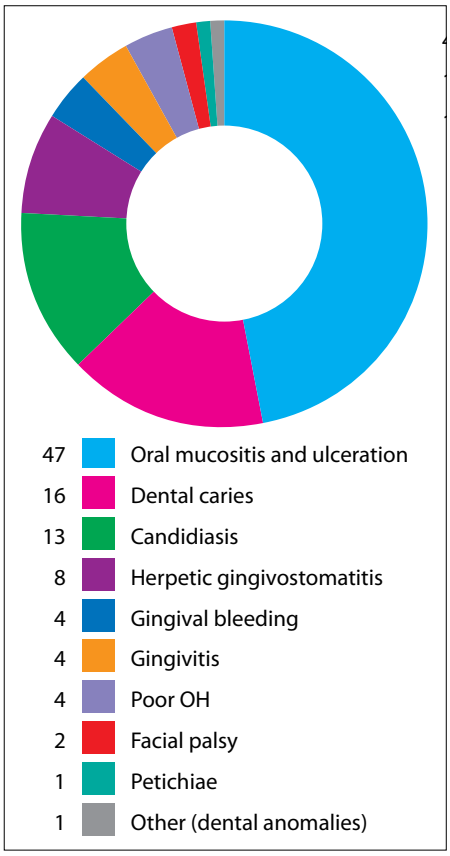

FIG. 1 Prevalence of overall oral health problems.

single case (0.8%) was reported in phase III. The majority of cases were reported 12 (10%) during phase IV. In patients who were off-treatment, oral mucositis and ulceration was reported in 3 cases (2.5%) and 7 (5.8%) in relapse cases. In records where the stage of treatment was not clear, 33 (27.5%) were reported. The overall prevalence of mucositis and ulceration was 63 (52.4%).

Oral candidiasis

The prevalence of oral candidiasis followed a similar trend as oral mucositis and ulceration (Table 3). No cases were reported before initiation of treatment and phase I. Subsequently, 2 cases (1.7%) were reported in phase II, and 1 more case (0.8%) in phase III, followed by 4 (3.3%) cases reported in phase IV. Post-treatment, 2 cases (1.7%) were reported, none occurred in relapse cases, and 8 (6.7%) in cases where treatment was unspecified. This makes the overall prevalence of reported cases of oral candidiasis 17 (14.2%).

Gingivitis, gingival bleeding, and herpetic gingivostomatitis

For gingivitis, gingival bleeding and herpetic gingivostomatitis (Table 3) cases were reported during the course of treatment for the first time as one case each during phases II and III for herpetic gingivostomatitis. During phase IV herpetic gingivostomatitis was reported in 5 cases (4.2%), followed by gingival bleeding in 2 cases (1.7%) and gingivitis in only 1 case (0.8%). Post treatment, only gingivitis and herpetic gingivostomatitis were reported in 3 (2.5%) and 1 (0.8%) cases respectively. Only 1 case (0.8%) from each category was reported in relapse cases. For unspecified stages, gingival bleeding and herpetic gingivostomatitis was reported in 2 cases (1.7%) for each. The overall prevalence reported for these gingival-related oral health problems was as follows: herpetic gingivostomatitis was reported in 11 cases (9.1%), gingivitis was reported in 5 cases (4.1%), and gingival bleeding was also reported in 5 (4.2%).

Dental caries and oral hygiene

Dental caries was reported during phases II and IV in 1 (0.8%) and 5 (4.2%) cases respectively. Post-treatment, it was reported in 6 cases (5%) and 10 (8.3%) in unspecified stages. This constituted of an overall of 22 cases (18.3%) of dental caries (Table 3). No single case over the course of the treatment was reported for oral hygiene status. It was only reported in 1 case (0.8%) post-treatment, and in 4 cases (3.3%) under the unspecified stages. An overall poor oral hygiene status was only reported in 5 (4.1%) cases.

Other findings

Out of four radiographs that were saved as part of the digital records, only two showed dental anomalies. One radiograph of a 10-year old patient (Fig. 2) showed microdontia, hypodontia, and arrested root development affecting several permanent teeth. The other radiograph of a 12-year old patient showed microdontia affecting three of four third permanent molars and taurodontism affecting one of four first permanent molars. Another two cases (1.7%) were reported for both oral petechiae and facial palsy.

Discussion

The five-year survival rate of childhood leukaemia ranges between 60-70% for AML, 60-80% for CML, and exceeds 85% for ALL patients. Success rates are likely to be higher with newer advancements in therapies despite the present existence of only short-term studies (especially in cases with CML) [ACS, 2015]. It is therefore important to understand the implication of the disease and its management on oral and dental health given its

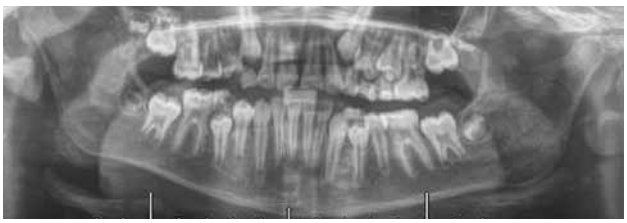

FIG. 2 Dental panoramic of a 10-year old leukaemic patient showing dental anomalies.

potential to affect the oral H-RQL adversely [Wong et al., 2012]. Additionally, severe oral and dental complications in such patients with compromised immune system and fragile health might affect the course of healing and, in extreme cases, lead to life threatening complications. It is worth noting that oral and dental sequelae was reported to affect up to 90% of paediatric oncology patients [Kumar et al., 2013].

In our study, data was collected from medical records of paediatric leukaemic patients in the only three governmental hospitals that provide paediatric oncology management in the UAE. In SKMC and Tawam Hospital, data was collected from digital files. A data collection sheet was used to fill in the data from the clinical notes including the stages of management, which facilitated recording the oral finding according to each phase. This was challenging, hence not feasible in Dubai Hospital because the medical records were paper-based. Clinical notes were not standardized and handwriting varied significantly between physicians. The stage of treatment was also unclear, something which lead us to recording the oral findings under the unspecified stage category in most instances.

Characteristics of study sample

Diagnosed patients in our study sample received treatment in either local specialised centres (62.5%), abroad (10%), or both (27.5%). Some of these countries were the United Kingdom, Egypt, and India. This variation could be the result of several contributing factors such as familial preference and socio-economic status. Our study found a significantly higher prevalence of oral complications among patients who received the complete course of treatment in local specialised centres. This may be due to the availability of full clinical notes for these patients before, during, and after the course of treatment.

Treatment protocols and oral health problems

Each hospital in our study implemented a different treatment protocol. The treatment protocol in SKMC is the Children's Oncology Group (COG) protocol, a combined protocol from both Children's Cancer Group (CCG) and Paediatric Oncology Group (POG). Tawam Hospital implements the CCG protocol while Dubai Hospital implements the Berlin-Frankfurt-Munster (BFM) protocol.

Four main phases are defined and are common to all protocols: induction, consolidation, delayed intensification, and maintenance. Despite the difference between protocols, they all include common chemotherapeutic agents that result in direct or indirect toxicity to stomatic cells [Morales-Rojas et al., 2012].

The most common chemotherapeutic agents resulting in adverse oral side effects are Methotrexate, Cytarabine, and Vincristine [Butturini and Gale, 1990].

The overall prevalence oral sequelae prevalence in our study was 60%. This was less than the prevalence reported by Ponce-Torres et al. [2010] (95%) but close to the reported figure in the review by Alnuaimi et al. [2014] (54%). These variations might be due to the burden of the disease and other critical conditions that can result in under-diagnosed and under-reported cases of complications. It also may be due to the fact that some of the study population received their treatment or part of it abroad; which might have affected the accuracy of documenting the occurrence of such complications.

Oral mucositis and ulceration

mucositis is the most prevalent oral sequelae in leukaemic children [Hosey and Welbury, 2012]. Rask et al. [1996] reported a 52% incidence of oral mucositis in children treated with Methotrexate, which was very similar to our results (52.4%). Figliolia [2008] and Subramaniam [2008] have also found that oral mucositis was the most common oral finding with 54% and 25.8% respectively. In contrast, Ponce-Torres et al. [2010] found that oral mucositis was the third most common oral manifestation affecting 38.77% of cases. The literature reports that oral mucositis can be seen during the induction phase especially when combined with radiotherapy in 34% and during the maintenance phase in 39% of the cases [Azher and Shiggaon, 2013]. In our study, no cases were reported during the induction phase while only 10% were reported in the maintenance phase. This may be due to under-recorded or under-diagnosed cases by physicians. The prevalence and severity of oral mucositis and ulceration depend on the treatment regimen employed. This involves high doses of Methotrexate and Cytarabine being particularly damaging to oral mucosae [Butturini and Gale, 1990]. Poor oral hygiene has also been found to play a critical role in determining the severity of oral mucositis [Yamashita et al., 2013]. The peak in severity occurs between days seven and ten after the initiation of chemotherapy and heals within two weeks from occurrence [Pico et al., 1998]. In our study, reduced oral intake was reported in some cases, something that might have been the consequence of the presence of severe oral mucositis. Several descriptions were reported in the relevant medical records, such as redness, ulceration, and mucositis; features which also reflected the variable stages of the condition. It was reported in some cases in our sample that oral mucositis and ulceration affected different sites in the oral cavity including the labial and buccal mucosa, tongue and gingivae.

Dental caries and oral hygiene

Our results have shown that several cases were reported involving dental caries (at least one tooth) and fewer cases with poor oral hygiene with an overall prevalence of 18.3% and 4.1% respectively. Involvement varied according to different phases of treatment, however; there was no pre-treatment examination. Ponce-Torres et al. [2010] reported a prevalence of 81.63%. However, Sonis et al. [1995] did not observe a difference in the prevalence of dental caries between the study and control groups. In

contrast, according to Mathur et al. [2012], dental caries does not occur as a result of the medical condition itself. It is due to alteration in salivary gland and salivary flow, changes in oral microflora, dietary habits, and difficulties in maintaining optimum oral hygiene as a result of the burden of the disease and other oral conditions [Mathur et al., 2012]. In our study, at least one carious tooth was reported by the medical team (tooth location only was specified) when there was either pain or parental concerns. This suggests that carious lesions may have existed before the initiation of cancer therapy or may have gone unnoticed due to an absence of complaints from the patient. In cases where the patient required full mouth rehabilitation under general anesthesia, carious teeth were reported by the dental team. Therefore, it was not feasible to measure the dmft or the DMFT because of the non-standardised documentation.

Oral candidiasis

While direct stomato-toxicity from chemotherapeutic agents results in oral mucositis, indirect stomato-toxicity can encourage opportunistic infections especially during periods of severe immunosuppression and neutropoenia [Pico et al., 1998]. Of these opportunistic infections, oral candidiasis is the most common, accounting for almost 15% of the cases. In our study, oral candidiasis was described in the clinical notes as candidiasis of the mouth or oral thrush and accounted for almost 14.2% of the cases; which was very close to Figliola's [2008] findings. In contrast, Subramaniam et al. [2008] reported only a 3.5% prevalence of oral candidiasis. This may be due to the reduced sample size in their study n=39 compared to our sample n=120. The most prevalent organisms are Candida (C.) albicans species affecting the oral cavity and paranasal sinuses [Scully, 2010]. Pico et al. [1998] found that 60-90% of the patients had positive cultures of C. species. In children and adolescents, the clinical presentation of candidiasis with C. albicans can be either pseudomembranous or erythematous with 29.78% and 12.77% respectively as reported by Gonzales et al. [2007]. The most common site of infection was the dorsal surface of the tongue. Our results showed that the prevalence of oral candidiasis followed a similar trend to oral mucositis and ulceration. The peak prevalence was reported in phase IV affecting almost 3.3%. The trend for both oral mucositis and candidiasis showed a gradual increase from phase I reaching a peak in phase IV with a drop in phase III. Epstein et al. [1996] found that oral candidiasis was associated with oral mucositis in which candidiasis was identified after the development of oral mucositis. This may explain the similar trends regarding both manifestations in our study.

Gingivitis, gingival bleeding, and herpetic gingivostomatitis

Our data show that a few gingivitis cases were reported (4.1%), gingival bleeding (4.2%), and herpetic gingivostomatitis (9.1%). The pattern of involvement revealed a gradual increase from the first reported cases in phase II to the peak occurring during phase IV. The pattern showed reduction in reported cases post-treatment and varied in relapsed cases. The possibility of under reporting of the cases of gingivitis is very likely especially in the asymptomatic ones. The medical entries were recorded by the medical team without the involvement of the dental team. This might have limited their diagnostic abilities and the recognition of gingivitis.

Ponce-Torres et al. [2010] reported a prevalence of 91.84% for gingivitis and 2.04% for herpetic gingivostomatitis. In contrast, Pels and Mielnik-Blaszczak [2012] found that leukaemic children had better oral hygiene compared to their controls, but with higher rates of gingival disease. This shows that the condition is multifactorial in which poor oral hygiene may aggravate the severity of gingivitis and gingival bleeding in conjunction with thrombocytopenia and neutropenia [Figliolia et al., 2008; Morales-Rojas et al., 2012]. According to Mathur et al. [2012], spontaneous mucosal petechiae and gingival bleeding can occur when the platelet level drops below 20,000 cells per mm^3.

Another gingival condition is gingival hyperplasia that is commonly seen in children with AML as a result of the infiltration of myeloid cells, but this is uncommon in children with ALL [Cho et al., 2000]. The majority of our cases were ALL with only one case of AML. Because of its rare occurrence in children, the sample was not representative enough to detect such manifestations.

Other oral signs of defective haemostasis are punctate petechiae and submucosal haemorrhage [Fayle et al., 1992]. Our results have shown that oral petechiae were reported in only 1.7% of the cases. It was reported by Ponce-Torres et al. [2010] in conjunction with other oral manifestations including dry mouth, mucosal pallor, and oral candidiasis in 6.12% of the cases.

Viral infections are not uncommon in leukaemic children. Wood and Corbitt [1985] found that herpes simplex virus and varicella-zoster virus are the most common viral pathogens, and its occurrence was highest during the induction and relapse phases. According to Figliolia [2008], they accounted for 8% and 2% in each phase respectively. Fayle [1992] reported that viral infections are manifested as single or multiple cold sores with vesiculation or crusting on or around the lips. In our study, the location of oral ulceration was reported in some records with the reference to the lips. These cases may have been herpetic ulcers that were under-diagnosed. The only reference to herpetic involvement was herpetic gingivostomatitis. Studies have shown that the peak incidence of herpetic gingivostomatitis occurs at two to five years of age [Hosey and Welbury, 2012].

Other findings

Where patients required dental management, dental panoramic radiographs were included within the clinical

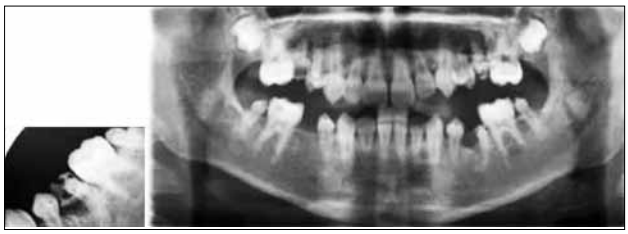

FIG. 3 Radiographs of a 12-year old leukaemic patient showing dental anomalies.

notes. These were reviewed for dental anomalies as a result of chemotherapy. Only two showed dental anomalies. One radiograph of a 10-year old patient (Fig. 2) showed microdontia affecting three of four third permanent molars and taurodontism affecting 1 of 4 first permanent molars. The other radiograph of a 12-year old patient (Fig. 3) showed microdontia, hypodontia, and arrested root development affecting several permanent teeth. Cranial neuropathies may affect the trigeminal or facial nerves, but are relatively uncommon. They can be manifested as jaw pain or facial palsies [Chamberlain, 2005]. Our results have shown that only 1.7% of the cases were reported and diagnosed with facial palsy. This occurs as a result of either infiltration of cancerous cells or secondary to chemotherapy [Chamberlain, 2005]. Fayle et al. [1992] found that vincristine can cause pain that mimics dental pain without any evidence of dental involvement.

Study limitations

Our study design was retrospective and relied on collecting data from clinical notes. A significant number of medical records had to be excluded because of incomplete documentation. Clinical notes have been documented by several physicians, which may have resulted in variations in reporting and documentation without standardisation. Regarding paper-based medical records, variations in handwriting was challenging in data collection.

Conclusion

Oral health problems as a result of leukaemia and its management are variable and are unavoidable. Oral health problem can result in serious impact on the child's overall health. Therefore, oral and dental care is of critical importance in maintaining the overall wellbeing of the patient before, during, and after treatment. This can be achieved by close liaison between the oncology and dental teams. Our study highlighted important oral health problems of leukaemic paediatric patients in the UAE that were not studied previously. It is recommended that future studies focus on measuring the incidence of oral health problems in leukaemic children. This can be achieved through prospective cohort studies. This will lead to a better understanding and facilitating the development of preventive and management strategies.

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References

› American Cancer Society (ACS). Childhood Leukemia [Online]. 2015. Available from: http://www.cancer.org/acs/groups/cid/documents/webcontent/003095-pdf [Accessed 31st May 2016].
› Alnuaimi E, El-Halabi M, Kowash M. Oral and Dental Considerations in the Management of Leukemic Children. ACCTRA. 2014;1(2):118-22.
› Azher U, Shiggaon N. Oral health status of children with acute lymphoblastic leukemia undergoing chemotherapy. Indian J Dent Res 2013;24(4):523.
› Butturini A, Gale RP. Oncogenes and leukemia. Leukemia 1990;4(2):138-60.
› Chamberlain MC. Leukemia and the nervous system. Curr Oncol Rep 2005;7(1):66-73.
› Cho S, Cheng A, Cheng M. Oral care for children with leukaemia. Hong Kong Medical J 2000;6(2):203-8.
› Da Fonseca MA. Oral and dental care of local and systemic diseases. In Casamassimo PS, Fields HW, McTigue DJ, Nowak A editors. Pediatric dentistry: infancy through adolescence. Philadelphia: Elsevier/Saunders; 2013. pp. 73-8.
› El-Hayek M, Trad O, Donner M, Hardy D. Pediatric oncology in the United Arab Emirates: The Tawam hospital experience. Medical and pediatric oncology 2003;41(5):486-7.
› Epstein JB, Ransier A, Lunn R, Chin E, Jacobson JJ, Le N et al. Prophylaxis of candidiasis in patients with leukemia and bone marrow transplants. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1996;81(3):291-6.
› Fayle SA, Duggal MS, Williams SA. Oral problems and the dentist's role in the management of paediatric oncology patients. Dent Update 1992;19(4):152-6, 8-9.
› Figliolia SL, Oliveira DT, Pereira MC, Lauris JR, Mauricio AR, Oliveira DT et al. Oral mucositis in acute lymphoblastic leukaemia: analysis of 169 paediatric patients. Oral diseases 2008;14(8):761-6.
› Gonzalez Gravina H, Gonzalez de Moran E, Zambrano O, Lozano Chourio M, Rodriguez de Valero S, Robertis S et al. Oral Candidiasis in children and adolescents with cancer. Identification of Candida spp. Med Oral Patol Oral Cir Bucal 2007;12(6):E419-23.
› Hallet KB, Alexander S, Wilson M, Munns C, Cameron AC, Widmer RP. Medically compromised children. In Cameron AC, Widmer RP editors. Handbook of pediatric dentistry. St. Louis: Mosby Elsevier Health Sciences; 2013. pp. 347-56.
› Hoffbrand V, Moss P. The aetiology and genetics of haematological malignancies. In Hoffbrand V, Moss P editors. Essential Haematology. Hoboken: Wiley; 2011. pp. 73-8.
› Hosey MT, Welbury R. Medical disability. In Welbury R, Duggal MS, Hosey MT editors. Paediatric dentistry. Oxford university press; 2012. pp. 343-4.
› Kumar N, Brooke A, Burke M, John R, O'Donnell A, Soldani F. The oral management of oncology patients requiring radiotherapy, chemotherapy and/or bone marrow transplantation. Faculty Dental Journal 2013;4(4):200-3.
› Mathur VP, Dhillon JK, Kalra G. Oral Health in Children with Leukemia. Indian J Palliat Care. 2012;18(1):12-8.
› Morales-Rojas T, Viera N, Moron-Medina A, Alvarez CJ, Alvarez A. Proinflammatory cytokines during the initial phase of oral mucositis in patients with acute lymphoblastic leukaemia. Int J Paediatr Dent 2012;22(3):191-6.
› Pels E, Mielnik-Blaszczak M. Oral hygiene in children suffering from acute lymphoblastic leukemia living in rural and urban regions. Ann Agric Environ Med 2012;19(3):529-33.
› Pico JL, Avila-Garavito A, Naccache P. Mucositis: Its Occurrence, consequences, and treatment in the oncology setting. Oncologist 1998;3(6):446-51.
› Ponce-Torres E, Ruiz-Rodriguez Mdel S, Alejo-Gonzalez F, Hernandez-Sierra JF, Pozos-Guillen Ade J. Oral manifestations in pediatric patients receiving chemotherapy for acute lymphoblastic leukemia. J Clin Pediatr Dent 2010;34(3):275-9.
› Pui CH. Childhood Leukemias. In Pui CH editors. Childhood Leukemias. Cambridge University Press; 2012. pp. 21.
› Pui CH. Childhood Leukemias. In Pui CH editors. Childhood Leukemias. Cambridge University Press; 2006. pp. 549, 293, 728-729.
› Rask C, Albertioni F, Schroder H, Peterson C. Oral mucositis in children with acute lymphoblastic leukemia after high-dose methotrexate treatment without delayed elimination of methotrexate: relation to pharmacokinetic parameters of methotrexate. J Pediatr Hematol Oncol 1996;13(4):359-67.
› Scully C. Haematology. In Scully C. editors. Medical problems in dentistry. London: Churchill Livingstone; 2010. pp. 220.
› Sonis AL, Waber DP, Sallan S, Tarbell NJ. The oral health of long-term survivors of acute lymphoblastic leukaemia: a comparison of three treatment modalities. Eur J Cancer Oral Oncology 1995;31b(4):250-2.
› Subramaniam P, Babu KL, Nagarathna J. Oral manifestations in acute lymphoblastic leukemic children under chemotherapy. J Clin Pediatr Dent 2008;32(4):319-24.
› Wong HM, Chu CH, Chan GCF, editors. Oral health-related quality of life among children undergoing cancer therapy. J Clin Oncol 2012; 30(suppl; abstr e12006) 36.
› Wood DJ, Corbitt G. Viral infections in childhood leukemia. J Infect Dis 1985;152(2):266-73.
› Yamashita K, Ohara M, Kojima T, Nishimura R, Ogawa T, Hino T et al. Prevalence of drug-resistant opportunistic microorganisms in oral cavity after treatment for oral cancer. J Oral Sci. 2013;55(2):145-55.