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USE OF CONE-BEAM COMPUTED TOMOGRAPHY IN PEDIATRIC PATIENTS: A RETROSPECTIVE OBSERVATIONAL STUDY

PEDİATRİK HASTALARDA KONİK IŞINLI BİLGİSAYARLI TOMOGRAFİ KULLANIMI: RETROSPEKTİF GÖZLEMSEL BİR ÇALIŞMA

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ABSTRACT

Objectives: This study aimed to determine and classify the reasons for cone-beam computed tomography (CBCT) imaging requests in the Oral and Maxillofacial Radiology Department, Istanbul University Faculty of Dentistry, and to examine which reasons more commonly require CBCT imaging.

Material and methods: From the local CBCT database, 956 pediatric patients gave their consent. Subsequently, age, gender, the reason for referral, a field of view (FOV), and referral departments were collected. Patients were grouped according to age distribution as 1-6 years, 7-12 years, and 13-17 years. Descriptive and comparative statistical analysis was performed.

Results: When CBCT referral reasons were analyzed, some of the most common requests were bone pathology (26.25%), impacted teeth (19.87%), dental anomalies (14.12%), cleft lip, and palate (13.91%), respectively. When referral reasons are evaluated according to age groups, dentoalveolar trauma (p=0.049), impacted teeth (p=0.000), dental anomalies, surgical applications (p=0.021), bone pathology (p=0.004), cleft lip and palate statistically significant differences were found between the (p=0.000) indications and age groups (p=0.000).

Conclusion: This study can guide dental practitioners in referring pediatric patients for three-dimensional imaging.

Keywords: Cone-beam computed tomography, field of view, indication, pediatric dentistry, radiation effects

ÖZ

Amaç: Bu çalışmada diş hekimliği fakültemizde konik ışınlı bilgisayarlı tomografi (KIBT) görüntüleme isteklerinin nedenlerinin belirlenmesi, sınıflandırılması ve hangi nedenlerin daha sık KIBT görüntüleme gerektirdiğinin incelenmesi amaçlanmıştır.

Gereç ve Yöntem: KIBT veri tabanından 956 pediatrik hasta incelenmiştir. Daha sonra yaş, cinsiyet, sevk nedeni, görüş alanı (FOV) ve sevk departmanları toplanmıştır. Hastalar yaş dağılımına göre 1-6 yaş, 7-12 yaş ve 13-17 yaş olarak gruplandırılmıştır. Tanımlayıcı ve karşılaştırmalı istatistiksel analiz yapılmıştır.

Bulgular: KIBT sevk nedenleri incelendiğinde en sık başvurulan istekler sırasıyla kemik patolojisi (%26,25), gömülü dişler (%19,87), diş anomalileri (%14,12), yarık dudak ve damak (%13,91) idi. Sevk nedenleri yaş gruplarına göre değerlendirildiğinde, dentoalveolar travma (p=0,049), gömülü dişler (p=0,000), diş anomalileri (p=0,000), cerrahi uygulamalar (p=0,021), kemik patolojisi (p=0,004), dudak damak yarığı, endikasyonlar ve yaş grupları arasında (p=0,000) istatistiksel olarak anlamlı fark bulundu.

Sonuç: Bu çalışma, diş hekimlerine üç boyutlu görüntüleme için çocuk hastaları sevk etmede rehberlik edebilir.

Keywords: Konik ışınlı bilgisayarlı tomografi, FOV, endikasyon, pediatrik diş hekimliği, radyasyonun etkileri

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INTRODUCTION

Cone-beam computed tomography (CBCT) is a three-dimensional imaging modality widely used in Dentistry to diagnose bone tissue in the maxillofacial region (1). The first CBCT was invented by British scientist Godfrey Housfield in 1967, developed from computerized tomography (2). Later, the first prototype was produced for radiotherapy and, in 1982, for angiography (2, 3). CBCT was developed independently and simultaneously by Arai et al. in Japan and by Mozzo et al. in Italy in the late 90s (4).

CBCT consists of an X-ray source and a detector rotating with this source; contrary to computerized tomography, not a fan-shaped but a conical-shaped radiation beam is sent through the region of interest (ROI). These projections are converted into a three-dimensional image (in axial, coronal, and sagittal planes, respectively) (4). Cone-beam imaging is used in dentistry to view high-contrast objects such as teeth and bone, as opposed to tasks that require soft tissue separations.

CBCT, based on a cone-shaped X-ray beam centered on a two-dimensional detector, can be used to diagnose pediatric dental clinic conditions involving impacted and supernumerary teeth (5-7). CBCT has many advantages: image accuracy, rapid scan time, reduced image artifact, reduced radiation dosage, and X-ray beam limitation (8). In addition; it provides less imaging time, easy data transfer, and less scattered radiation in comparison to computed tomography (CT) (6, 9).

Considering that children are more susceptible to the risks of ionizing radiation, every effort should be made to minimize the radiation burden while maintaining sufficient diagnostic yield (10, 11). The American Academy of Pediatric Dentistry (AAPD) recommends that CBCT use in pediatric dentistry be considered when conventional radiographs are inadequate for diagnosis and treatment planning and when the potential benefits outweigh the risk of additional radiation dose. It also emphasizes that it should not be routinely prescribed for diagnostic or screening purposes without clinical indications (12).

In children, CBCT images have been used to evaluate impacted teeth, airway analysis, and for periodontal, endodontic, and orthodontic purposes (13). According to the current guidelines of the AAPD, CBCT can be used for assessing the periapical pathosis in endodontics, oral pathology, anomalies in the developing dentition (e.g., impacted, ectopic, or supernumerary teeth), oral maxillofacial surgery (e.g., cleft palate), dental and facial trauma, and orthodontic and surgical preparation for orthognathic surgery (12). Nevertheless, there is limited evidence about the appropriate use of CBCT in children and adolescents. Still, guides on this subject are essential to reduce radiation risks in this age group. The SEDENTEXCT guidelines allow for several recommendations for usage. However, there are no unambiguous guidelines for pediatric dentistry (14). Although, the European DIMITRA project (dentomaxillofacial paediatric imaging: an investigation toward low-dose radiation induced risks) was focused on the pediatric field (15). The following CBCT suggestions in pediatric patients are mentioned in the position statement: -Impacted and supplementary teeth, -Dentoalveolar trauma, -Orofacial clefts, -Dental anomalies, -Bone pathology -Cone-beam-CT-based surgical planning of autotransplantation, -Syndromes. On the other hand, there are deficiencies in the DIMITRA position statement published in 2018: suggestions such as -TMJ/condylar abnormalities, -facial asymmetry, -surgical applications, -endodontics, -orthodontics. These suggestions should be added to or expanded upon.

This study aimed to develop evidence-based research on using CBCT in pediatric dentistry, including referral criteria. This retrospective study evaluated the referral reasons for CBCT in pediatric individuals.

MATERIALS and METHODS

The institutional review board approved the study protocol of the local clinic (Date: 10.01.2019, No: 78).

We performed a retrospective analysis of 956 patients under the age of 18 years who underwent a CBCT scan in our clinic between December 2015 and 2018 for three years.

All scans were taken with the CBCT-unit Soredex SCANORA®3Dx (Tuusula, Finland) and were stored in the OnDemand 3D Project Viewer Cybermed Inc. (California, USA) database. The CBCT device we used to have 8 different FOV (field-of-view) options; 50x50mm, 50x100mm, 80x100mm, 80x160mm, 140x100mm, 140x165mm, 180x165mm and 240x165mm. All parents signed a letter of consent permitting to use of data for research purposes before CBCT scans were taken. When there were multiple CBCTs per patient, only the first CBCT was included. Our study did not include low-image quality images and motion or metal artifacts. Figure 1 illustrated the study selection.

We evaluated the patients according to age, gender, the reason for referrals, Field of View (FOV), and referral departments: dentomaxillofacial radiology, oral and maxillofacial surgery, endodontics, periodontology, orthodontics, pedodontics, prosthodontics, and restorative dentistry. Patients were grouped according to age distribution as 1-6 years, 7-12 years, and 13-17 years.

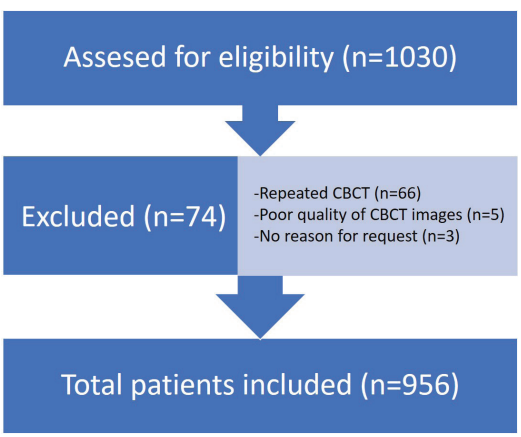

Figure 1: Flowchart

Based on the reason for referrals, the references for the SEDENTEXCT guideline were categorized under the following headings: Dent alveolar trauma, Facial trauma, Craniofacial anomalies and syndromes, Facial asymmetry, Dental anomalies, Surgical applications, TMJ/condylar abnormalities, Bone pathology, Cleft lip and palate, Endodontics, Orthodontics, Other.

Statistical analysis was performed for descriptive and comparative statistics using IBM® SPSS 25.0 (SPSS Inc, Chicago, IL, USA). The Pearson chi-square test was used for the statistical evaluation of categorical variables, and a p-value below 0.05 was considered statistically significant.

RESULTS

In the present study, 956 patients (451 females, 505 males) with a mean age of 13.19±3.281 (range 1-17) were examined. When the reasons for CBCT requests were analyzed, some of the most common requests in 956 patients were bone pathology (26.25%), impacted teeth (19.87%), dental anomalies (14.12%), cleft lip and palate (13.91%), and the distribution of all requests by gender is shown in the Table 1.

Table 1: Clinical indications for the cone-beam computed tomography (CBCT) examinations in the study

Indications	Females		Males		Total		p
	n	%	n	%	n	%	
Dentoalveolar trauma	10	2.21	16	3.16	26	2.71	0.482**
Facial trauma	19	4.21	22	4.35	41	4.28	1**
Craniofacial anomalies and syndromes	11	2.43	9	1.78	20	2.09	0.630**
Facial asymmetry	7	1.55	3	0.59	10	1.04	0.205***
Impacted teeth	102	22.61	88	1.74	190	19.87	**0.045***
Dental anomalies	48	10.64	87	17.22	135	14.12	**0.004***
Surgical applications	18	3.99	12	2.37	30	3.13	0.214**
TMJ/condylar abnormalities	8	1.77	10	1.98	18	1.88	1**
Bone pathology	119	26.38	132	26.13	251	26.25	0.931*
Cleft lip and palate	51	11.30	82	16.23	133	1.39	**0.028***
Endodontics	4	0.88	1	0.19	5	0.52	0.194***
Orthodontics	14	3.10	9	1.78	23	2.40	0.263**
Other	40	8.86	34	6.73	74	7.74	0.217*
Total	451		505		956	100	

*Pearson chi-square test, **Yates chi-square test, ***Fisher exact test

Patients were grouped according to age distribution as 1-6 years (n=36), 7-12 years (n=317), and 13-17 years (n=603). When the CBCT referral reasons are evaluated according to age groups, dentoalveolar trauma (p=0.049), impacted teeth (p=0.000), dental anomalies (p=0.000), surgical applications (p=0.021), bone pathology (p=0.004), cleft lip and palate (p=0.000), statistically significant differences were found between indications and age groups. The results are shown in Table 2. In addition, dental anomalies (22.22%) and bone pathology (22.22%) were the most common reasons for requests in the 1-6 age group. In the 7-12 age group, the most common reason for the request is dental anomalies, with a rate of 26.49%. The most common referral reason in the 13-17 age group is bone pathology with 29.85%.

When the FOV ranges of the CBCT device used according to age were examined, it was seen that the highest rate of images (43.1%) was obtained in all age groups with a FOV range of 50x100mm, and the FOV distribution is shown in Figure 2.

When the regions of interest (ROI) were evaluated, it was seen that the images were taken from the maxilla region at the highest rate in all age groups (1-6, 7-12, 13-17) (58%, 53%, 49%, respectively). While the images taken from the mandible region at the ages of 1-6 and 7-12 are at the lowest rate (11%, 21%, respectively), the images taken from the double chin in the 13-17 age group are less common (18.6%) compared to other regions in this age group (Figure 3).

When the departments that referral reasons for CBCT are examined, the departments that request CBCT the most in the 1-6 age group, respectively; Pedodontics Department (58.33%), Surgery Department (27.77%), Orthodontics (13.88%). In the 7-12 age group, Pedodontics Department (55.20%), Surgery Department (29.33%), Orthodontic Department (15.45%). In the 13-17 age group, the Department of Surgery (33.49%), Pedodontics (30.34%), Dentomaxillofacial Radiology (21.72%), and others are shown in detail in Figure 4.

DISCUSSION

There are a limited number of studies on the use of CBCT in pediatric patients, and these studies are based on different indications and in various age groups. The present study evaluated the

Table 2: Distribution of CBCT indications by age group

Indications	Group 1	Group 2	Group 3		p
	n (%)	n (%)	n (%)	Total (%)	
Dentoalveolar trauma	3 (8.33)	5 (1.57)	18 (2.98)	26 (2.71)	**0.049**
Facial trauma	4 (11.11)	16 (5.04)	21 (3.48)	41 (4.28)	0.065
Craniofacial anomalies and syndromes	2 (5.55)	4 (1.26)	14 (2.32)	20 (2.09)	0.189
Facial asymmetry	0 (0)	2 (0.63)	8 (1.32)	10 (1.04)	0.505
Impacted teeth	5 (13.88)	41 (12.93)	144 (23.88)	190 (19.87)	**0.000**
Dental anomalies	8 (22.22)	84 (26.49)	43 (7.13)	135 (14.12)	**0.000**
Surgical applications	1 (2.77)	3 (0.94)	26 (4.31)	30 (3.13)	**0.021**
TMJ/condylar abnormalities	1 (2.77)	7 (2.20)	10 (1.65)	18 (1.88)	0.778
Bone pathology	8 (22.22)	63 (19.87)	180 (29.85)	251 (26.25)	**0.004**
Cleft lip and palate	2 (5.55)	68 (21.45)	63 (10.44)	133 (13.91)	**0.000**
Endodontics	0 (0)	1 (0.31)	4 (0.66)	5 (0.52)	0.712
Orthodontics	0 (0)	4 (1.26)	19 (3.15)	23 (2.40)	0.130
Other	2 (5.55)	19 (5.99)	53 (8.78)	74 (7.74)	0.283
Total	36	317	603	956	

Group 1: Age 1–6 years, group 2: Age 7–12 years, group 3: Age 13–17 years, CBCT: Cone beam computed tomography

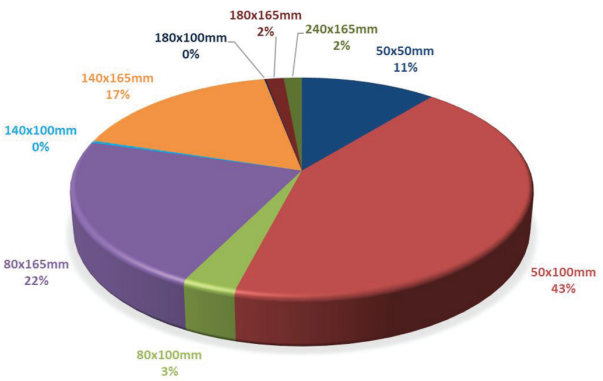

Figure 2: Distribution of the FOVs by number (n=956)

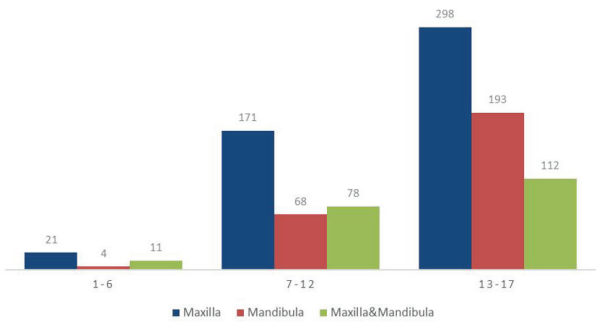

Figure 3: Distribution of the dentomaxillofacial areas by age groups

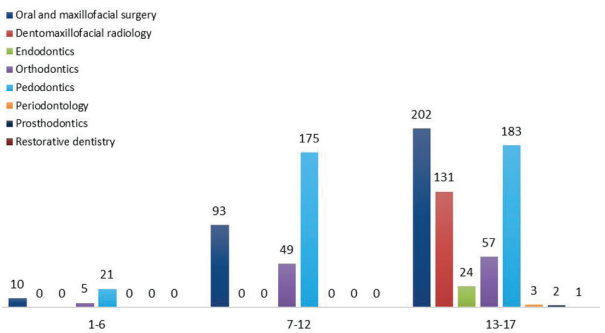

Figure 4: Distribution of Departments Requesting CBCT by Age

referral reasons for CBCT in pediatric patients at a higher rate (956 CBCT) than other studies (4, 13, 16-18). The present study focused on the basis for CBCT referrals according to the guidelines SEDENTEXCT and DIMITRA for clinical use in pediatric patients in a Turkish subpopulation (14, 15). In the DIMITRA position statement, we found that although it was intended to determine the CBCT indications in the pediatric patient group, there was no category for some indications (15). For this reason, we have categorized the request reasons based on SEDENTEXCT. In our study, different from the DIMITRA position statement, the following were added: Facial trauma, Facial asymmetry, Surgical applications, TMJ/condylar abnormalities, Endodontics, and Orthodontics.

There are limited resources in the literature investigating the referral reasons for CBCT in the pediatric population. Some of the indications reported among the causes of CBCT imaging

in pediatric patients in the literature are: an eruption of the dentition, viewing local resorptions associated with unerupted teeth, and examining the severity of facial traumas (19). In the study of Isman et al., the most common CBCT referral reason was; malocclusion and dentofacial anomalies with the highest rate in primary and permanent dentition, and impacted tooth localization in mixed dentition were the most common reasons for the indication (13). In the study of Van Acker et al., the most common CBCT referral reason was developing dentition-localized (4). Unlike other studies, bone pathology was the most common reason for CBCT referrals. In the present study, patients with bone pathology were mainly diagnosed with deeply carious teeth and radicular cysts caused by lesions in the related teeth. We think that the higher rate of bone pathology due to dental infectious conditions is the most common reason for the request in our study. At the same time, it is reported in the literature that caries and caries-related lesions are seen more frequently in the Turkish population (20). Compared to other studies, we can explain the higher incidence of bone pathology requests in our research in this way.

In the present study, we evaluated the referral reasons for CBCT patients under 18 years old. In similar studies in the literature, the mean age ranged from 8.3 to 13.42, from high to low, respectively; Yiğit et al., Isman et al., the present study, Hidalgo et al., Van Acker et al., Gümrü et al., Suzuki et al., mean age respectively; 14.32, 13.42, 13.19, 13.1, 12.35, 11.15, 8.3. (4, 13, 16, 17, 18, 21). In any way, this is induced by differences in referral reasons and racial differences. In the study of Isman et al. the most common indication for CBCT was malocclusion and dentomaxillofacial anomalies in the primary and permanent dentition age groups, whereas the localisation of impacted teeth was the most common indication in the mixed dentition age group (13). In the study of Van Acker et al. the most CBCT request (36%) was the developing dentition-localized which consists for the greatest part typically for second transitional period and the permanent dentition (4). In the study of Yigit et al. CBCT request in the 12- to 18-year age group is mostly impacted teeth (21). In the present study, similar to the Isman et al., CBCT indication in the 1- to 6-year age group and the 7- to 12-year age group were mostly dental anomalies (13). However, in our study, unlike the literature (4, 13, 21), the bone pathology was the most common indication in the 13- to 17-year age group.

Fundamental principles and guidelines for the use of CBCT include: 1) use appropriate image size or field of view, 2) assess radiation dose risk, 3) minimize patient radiation exposure, and 4) maintain professional competence in performing and interpreting CBCT studies (12). Published research on the pediatric use of CBCT mentions that a smaller field of view (FOV) in the pediatric population may meet the prescribing physician's or dentist's needs. The smaller the FOV used, the less effective the patient receives. When referring a patient to CBCT screening, the dentist should provide the CBCT practitioner with adequate clinical information (19). Van Acker et al. most commonly used a small FOV size of 50x55 mm at 81.5% (4). In the present study, it was observed that a maximum FOV of 50x100 mm was used with a rate of 43.1%, and it can be associated with referral reasons.

Contrary to the benefits of CBCT imaging, the radiation dose is higher than a single conventional periapical or panoramic radiograph (13). With this in mind, CBCT should be justified before imaging, as with any radiographic examination. The potential benefits of CBCT must outweigh the harms associated with exposure to ionizing radiation. A radiological examination should be performed with ALARA (As Low as Reasonably Achievable), a safety principle designed to minimize radiation doses and release radioactive materials (3). Many reasons can be counted among the reasons for the need for CBCT imaging, and the classification and standardization of these reasons will benefit physicians who will request CBCT. Our study is among the evidence that will contribute to developing existing guidelines on this subject. In the present study, the chi-square test revealed the relations between two categorical variables. The chi-squared test applied an approximation assuming the sample is large, while the Fisher's exact test and Yates's correction for continuity were used to provide a more conservative result for contingency tables with small cell counts. The limited number of samples and the evaluation of the archive belonging to a single center can be counted among the limitations of our study.

CONCLUSION

In the present study, it was revealed that the most common indication for CBCT was bone pathology and secondly impacted teeth. Research on the use of CBCT in dentistry in children is limited. Since the CBCT device contains ionizing radiation, it is important to master the use of CBCT in children in appropriate indications. Therefore, there is a need for detailed guidelines on the use of CBCT in the pediatric field.

Ethics Committee Approval: This study was approved by Istanbul University, Faculty of Dentistry Clinical Research Ethics Committee (Date: 10.01.2019, No: 78).

Peer Review: Externally peer-reviewed.

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