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ON THE TRADE-OFF BETWEEN IMAGING DATA AND THE INDICATIONS OF CONE-BEAM COMPUTED TOMOGRAPHY: A RETROSPECTIVE STUDY

GÖRÜNTÜLEME VERİLERİ İLE KONIK IŞINLI BİLGİSAYARLI TOMOGRAFİ ENDİKASYONLARI ARASINDAKİ İLİŞKİNİN RETROSPEKTİF OLARAK DEĞERLENDİRİLMESİ

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ABSTRACT

Objective: The European Academy of Dentomaxillofacial Radiology (EADMFR) implemented the Safety and Efficacy of a New and Emerging Dental X-ray Modality (SEDENTEXCT) Project in 2009 to determine the basic principles of cone-beam computed tomography (CBCT) use and established detailed criteria for specializations. One of these principles states that the correct selection of the field of view (FOV) is critical to lowering the effective radiation dose. This study aims to retrospectively analyze CBCT indications and FOV selections as determined by the clinicians in different departments.

Materials and Methods: A total of 8,955 patients' CBCT data acquired between 2015-2019 were retrospectively scanned. Data were collected and evaluated according to criteria such as FOV, acquisition indications, age, and gender. The chi-square test was used to study the differences between groups with regard to the evaluations among categorical variables.

Results: A statistically significant difference was found when comparing FOV values with CBCT indications (p = 0.000). Images with the highest FOV value of 240 mm x 165 mm were taken primarily for orthognathic surgery planning. The smallest FOV value of 50 mm x 50 mm was seen to be preferred for apical pathologies and odontogenic cysts.

Conclusion: Following the guidelines in the literature, the highest FOV is observed to have been used for cases that cover a larger area, such as is required in orthognathic surgery, while the smallest FOV is observed to be frequently used for endodontic cases performed to evaluate small structures such as root canal morphology and apical pathologies.

Keywords: cone-beam computed tomography, radiation, radiobiology, field of view

ÖZ

Amaç: Avrupa Dental ve Maksillofasiyal Radyoloji Akademisi, konik ışınlı bilgisayarlı tomografi (KIBT) kullanımının temel ilkelerini belirlemek için 2009 yılında SEDENTEXCT projesini uygulamış ve uzmanlıklar için ayrıntılı temel kriterler oluşturmuştur. Bu ilkelerden biri, görüntüleme alanının doğru boyutlandırılmasının radyasyon dozu için kritik olduğunu belirtir. Bu çalışma, KIBT verilerini geriye dönük olarak analiz etmeyi ve farklı bölümlerdeki klinisyenler için belirlenen KIBT endikasyonlarını ve görüntülenen bölgenin büyüklüğünü (FOV) araştırmayı amaçlamaktadır.

Gereç ve Yöntem: Toplam 8955 hastanın 2015-2019 yılları arasında elde edilen KIBT verileri geriye dönük olarak taranmıştır. Veriler, FOV, endikasyon, yaş ve cinsiyet gibi kriterlere göre değerlendirilmiştir. Kategorik değişkenler arasındaki değerlendirmelerde gruplar arasındaki farkı araştırmak için ki-kare testi kullanılmıştır.

Bulgular: FOV değerleri ile istek nedenleri karşılaştırıldığında istatistiksel olarak anlamlı fark bulunmuştur (p=0,000). En yüksek FOV değeri 240 mm x 165 mm olan görüntüler çoğunlukla ortognatik cerrahi öncesi planlama için alınmıştır. Küçük alanlardaki apikal patolojiler ve odontojenik kistler için 50 mm x 50 mm olan en küçük FOV değerinin tercih edildiği görülmüştür.

Sonuç: Literatürdeki kılavuzlar izlenerek, ortognatik cerrahide gerektiği gibi daha geniş alanı kapsayan vakalarda en yüksek FOV'un kullanıldığı, en küçük FOV'un ise kök kanal morfolojisi ve apikal patolojilerin incelenmesi gibi endodontik nedenlerle sıklıkla kullanıldığı görülmüştür.

Anahtar Kelimeler: Konik Işınlı Bilgisayarlı Tomografi, Radyasyon, Radyobiyoloji, FOV

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INTRODUCTION

The first definition and introduction of cone-beam computed tomography (CBCT) were made 20 years ago by an Italian group from Verona (1). Imaging methods such as CBCT and panoramic radiography play an essential role in diagnosis and treatment planning in dentistry (2). Conventional radiographic techniques such as panoramic and periapical radiography have been widely used for many years (2). Disadvantages such as superposition, two-dimensional imaging, and image distortion have led to the search for different imaging techniques (2). The radiation protection guidelines suggest that the potential benefits of an imaging method should outweigh the risks (3). Therefore, CBCTs should only be used when conventional methods are unable to identify any lesion. Therefore, evaluating the imaging indications precisely is crucial.

CBCT has become widely available and easily accessible to many users in universities, dental hospitals, and dental clinics (1). CBCT consists of both an x-ray source and a detector rotating with this source (4). When using CBCT, the image area needs to be accurately determined in order to avoid excessive radiation doses. The field of view (FOV) corresponds to the size of the scanned area that will be visualized. Commercially available devices have different FOV sizes (4). The smallest FOV should be preferred in cases where a small area is to be examined in detail with thin slices at high resolution. If a large area is to be evaluated in the craniomaxillofacial region, selecting a high FOV would be appropriate.

CBCT images provide information for diagnosis, treatment planning, and follow-up (1). Orthodontists and surgeons use CBCT for facial asymmetry, complex dentoskeletal relationships, and facial aesthetic evaluations in planning orthognathic operations (1, 5-7). Endodontists use CBCT to evaluate dentoalveolar trauma, root fractures, and root canal morphology (1, 3, 4, 8). Although the number of studies is limited with regard to periodontology, CBCT is beneficial for evaluating furcation defects and buccal-lingual bone defects (1, 5-7). In implantology, CBCT provides cross-sectional images in various planes that allow for height, width, and angulation to be assessed. Moreover, the exact positions can be determined for anatomical landmarks such as the mandibular canal, mental foramen, and maxillary sinus floor (3, 4, 8). Maxillofacial surgeons use CBCT for many indications, such as detecting dentoalveolar-maxillofacial pathologies, maxillofacial fractures, sialolithiasis, evaluation of the bony components of TMJ, and anatomical landmarks that are in close proximity to the surgical area, such as the mandibular canal. Proper use of CBCT is the joint responsibility of the clinician and radiologist (6).

The European Academy of Dentomaxillofacial Radiology (EADMFR) implemented the Safety and Efficacy of a New and Emerging Dental X-ray Modality (SEDENTEXCT) Project in 2009 to determine the basic principles of CBCT use and to establish detailed criteria for specializations. One of these principles states proper FOV selection to be critical for lowering the effective radiation dose (4, 9). This study aims to retrospectively analyze CBCT indications and FOV selections that the clinicians in different departments had determined.

MATERIALS and METHODS

CBCT images obtained with the Scanora 3Dx brand CBCT device (Scanora® 3Dx, Soredex, Tuusula, Finland) were evaluated at the Istanbul University Faculty of Dentistry, Department of Dentomaxillofacial Radiology. The minimum FOV size of the device is 50 mm x 50 mm (height x radius), and the maximum FOV size is 180 mm x 165 mm. However, the maximum FOV can be as large as 240 mm x 165 mm by using stitching. Therefore, our study determined the maximum FOV as 240 mm x165 mm. Voxel size varies between 0.1-0.5 mm^3, and cross-section thickness also varies between 0.1-0.3 mm with respect to the selected FOV. The imaging parameters of the device are 60-90 kVp and 4-10 mA.

A total of 8,955 patients' CBCT data acquired between 2015-2019 were retrospectively scanned. Data were collected and evaluated according to criteria such as FOV, acquisition indications, age, and gender.

IBM Statistical Package for the Social Sciences (SPSS) Statistics (v28.0) was used for the statistical analysis in our study. We considered a value of 0.05 as the degree of significance. The chi-square test was used to study inter-group differences among categorical variables in the evaluations. Frequency distributions were determined for the categorical variables.

RESULTS

The mean ages for males and females were 36.92 and 38.12, respectively. The oral and maxillofacial surgery department was determined to have referred the majority of the patients who'd been indicated for a CBCT scan. Restorative dentistry was also determined as the department that made the fewest of these referrals. The most requested FOV was observed for all departments to be the 50 mm x 100 mm FOV (p = 0.000; Table I). A statistically significant difference was found when comparing the FOV values with the indications (p = 0.000). Images with the highest FOV value of 240 mm x 165 mm were acquired primarily for orthognathic surgery planning, while the smallest FOV value of 50 mm x 50 mm was seen to be preferred for apical pathologies and odontogenic cysts (Table II). A statistically significant difference was also seen when comparing the indications with departments' CBCT referrals (p = 0.000). The Oral and Maxillofacial Surgery, Dentomaxillofacial Radiology, Endodontics, Periodontology, and Restorative Dentistry Departments were detected to have mostly requested CBCT scans due to apical lesions and odontogenic and non-odontogenic cysts and tumors. We observed the Orthodontics Department to have primarily requested CBCT scans due to jaw deformities and the Prosthodontics Department to have primarily requested CBCT scans due to dental implant evaluations (Table III).

Table I: Comparison of FOV values of departments requesting tomography

Department	50 mm x 50 mm	50 mm x 100 mm	80 mm x 100 mm	80 mm x 165 mm	140 mm x 165 mm	180 mm x165 mm	240 mm x 165 mm	p
	(n)	(n)	(n)	(n)	(n)	(n)	(n)	
Oral and Maxillofacial Surgery	83	642	390	481	575	27	24	0,000*
Dentomaxillofacial Radiology	81	241	137	167	262	22	19	
Endodontics	86	53	13	4	5	1	0	
Orthodontics	3	4	4	1	2	0	19	
Periodontology	8	40	8	6	5	0	0	
Prosthodontics	4	14	5	8	9	0	0	
Restorative Dentistry	2	1	1	0	0	0	0	

**Pearson Chi-Square*

DISCUSSION

CBCT is an imaging technique that guides dentists, especially radiologists and surgeons, with regard to many pathologies by providing a three-dimensional evaluation. Avoiding unindicated scans is essential due to the higher radiation dose compared to conventional imaging techniques. Limiting the FOV as much as possible is the most basic method for reducing the dose (7). Dentomaxillofacial radiologists should determine the appropriate FOV size after performing an examination. In addition, CBCT should not be performed in cases where ultrasonography and magnetic resonance imaging would be sufficient for the radiological examination (5).

In this study, we evaluated the complete database of CBCT images that we had supervised during the referral stage in our university. Some countries have not legally approved the operation of CBCT devices without the supervision of a dentomaxillofacial radiologist (10). In a 2012 survey conducted in 29 CBCT clinics in Norway, CBCT was mainly indicated for implant planning and impacted teeth (11). However, our study determined that CBCT had mostly been indicated for apical pathologies and odontogenic/non-odontogenic cysts.

Various FOV ranges have been used in oral and maxillofacial surgeries to determine the localization of third molars (12-14). In this study, pathologies such as cysts and tumors were the most common referrals from oral and maxillofacial surgery. Many FOV values were taken, with 50 mm x 100 mm, 80 mm x 160 mm, and 140 mm x 160 mm being the most common. Studies have reported endodontists to require CBCTs at the smallest FOV values to examine root resorption and canal morphology (1).

Hajem et al. study on 617 patients in Sweden reported orthodontists to request CBCT scans more than surgeons and CBCT to

Table II: Comparison of FOV values with indications

Indications	50 mm x 50 mm	50 mm x 100 mm	80 mm x 100 mm	80 mm x 165 mm	140 mm x 165 mm	180 mm x 165 mm	240 mm x 165 mm	*p*
	(n)	(n)	(n)	(n)	(n)	(n)	(n)	
Anatomical / Neural Relationship	9	40	15	133	3	0	0	0,000*
Apical Resections	5	4	2	0	1	0	0	
Asymmetry	0	0	0	1	10	0	0	
Calcifications	1	0	1	1	0	0	0	
Cleft Palate	0	6	29	4	43	8	2	
Condyle Fracture	0	1	0	3	15	0	2	
Control for Surgery	4	30	20	18	50	3	4	
Cyst,Tumour and Other Pathologies	99	414	195	214	131	5	1	
Dental Anomaly	0	0	0	0	10	1	2	
Dental Implant	0	6	0	1	4	0	0	
Dental Resorption	7	3	1	0	0	0	0	
Dental Eruption Guidance	0	4	2	0	0	0	0	
Endodontic Reasons	3	2	2	0	0	0	0	
Expansion	1	2	3	2	1	0	0	
Other Bone Evaluation Purposes (Osteomyelitis, Odontoma etc.)	11	55	19	36	69	1	3	
For Orthognathic Surgery	1	0	1	0	67	4	22	
Graft Evaluation	0	6	7	2	4	0	0	
Hyperplastic Condyle	0	1	0	0	3	1	1	
Impacted Teeth	20	155	94	90	36	9	3	
Infection	1	10	3	8	5	1	0	
Maxillofacial Anomaly	0	1	1	1	1	0	0	
MRONJ	0	6	3	10	116	2	0	
Orthodontic Reasons	0	2	0	0	6	0	1	
Other Reasons	53	128	62	78	140	10	8	
Pain	19	58	27	24	28	1	1	
Resorption	1	4	1	3	4	0	0	
Salivary Gland Diseases	0	3	2	4	1	0	0	
Sinus Pathologies	2	26	60	4	11	1	0	
Supernumerary Tooth	12	39	7	1	5	1	0	
Facial swelling-Abscess	20	23	22	13	23	2	1	
Syndromes	0	1	1	0	7	2	6	
TMJ Diseases	0	2	4	4	49	1	3	
Trauma	20	20	8	17	43	8	4	

**Pearson Chi-Square*

Table II: Comparison of requesting departments with indications

Indications	Oral and Maxillofacial Surgery	Dentomaxillofacial Radiology	Endodontics	Orthodontics	Periodontology	Prosthodontics	Restorative Dentistry	p*
Pain	176	66	49	0	18	4	2	
Dental Implant	433	92	7	2	21	38	0	
Maxillofacial Anomaly	6	6	0	0	1	0	1	
Other Reasons	606	330	64	18	25	17	1	
Expansion	23	15	1	0	1	1	1	
Endodontic Reasons	3	7	5	1	0	0	1	
Infection	47	8	10	0	1	1	0	
Impacted Teeth	512	289	9	16	6	10	2	
Graft Evaluation	28	5	0	1	1	0	0	
Hyperplastic Condyle	17	10	0	0	0	0	0	
Apical Resections	19	6	3	0	3	0	0	
Cyst,Tumour and Other Pathologies	1563	925	103	1	28	20	3	
Condyle Fracture	26	15	0	0	0	2	0	
Calcifications	7	12	1	0	0	1	0	
Control for Surgery	181	44	2	1	8	3	0	
Orthodontic Reasons	7	7	0	0	0	0	0	
For Orthognathic Surgery	95	24	0	27	0	0	0	0,000
Other Bone Evaluation Purposes (Osteomyelitis, Odontoma etc.)	212	162	1	0	14	4	1	
Resorption	13	6	1	0	0	1	0	
Syndromes	8	16	0	2	0	0	0	
Anatomical / Neural Relationship	253	50	11	1	3	3	0	
Asymmetry	15	17	1	0	0	1	0	
Sinus Pathologies	176	74	10	0	5	5	1	
Supernumerary Tooth	73	16	1	0	0	1	0	
Dental Eruption Guidance	4	3	0	1	0	0	0	
Facial Swelling-Abscess	139	77	55	0	2	2	1	
TMJ Diseases	80	55	1	1	1	3	0	
Trauma	167	118	39	0	2	5	0	
Salivary Gland Diseases	16	12	0	0	0	0	0	
Cleft Palate	30	112	0	12	0	0	0	
MRONJ	177	46	0	0	2	0	0	
Dental Anomaly	20	9	2	1	0	0	1	
Dental Resorption	1	8	11	0	0	1	0	

**Pearson Chi-Square*

have been obtained most frequently with the indications of impacted canines and tooth resorption (10). Unlike the literature, our study has found orthodontists to most frequently request CBCT scans for orthognathic pre-surgery planning.

Due to involving ionizing radiation, CBCT scans necessitate that careless use be avoided and should only be used if the benefits outweigh the risks. FOV values should be suitable for the size of the region being investigated. When following the guidelines in the literature, the highest FOV is observed to have been used for cases that cover a larger area, such as is required in orthognathic surgery, and the smallest FOV is observed to have been frequently used for endodontic cases that are performed to evaluate small structures such as root canal morphology and apical pathologies.

Ethics Committee Approval: This study was approved by Istanbul University Faculty of Dentistry Clinical Research Ethics Committee (Date: 14.12.2021, No: 2021/65).

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