Journal of Current Research in Oral Surgery
2021, Volume 1, Page No: 30-36

Available online at: www.tsdp.net

TSDP
Turkish Specialized Dental Publication

Original Article

Patterns and Indications for Cone Beam CT Referrals in Academic Dental Institutions

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Received: 16 August 2021; **Revised:** 02 October 2021; **Accepted:** 06 October 2021

ABSTRACT

This study aims to investigate the reason for referral for cone-beam computed tomography (CBCT) evaluation in a university-based setting, as well as the characteristics of the referring dentists. A total of 546 referral forms were selected using a systematic sampling method, and various factors including patient-related factors (age, gender) were recorded. The patients were 37.5 years old on average. Implant site evaluation was the most commonly reported reason for referral (46.7%), followed by determining the proximity of the root to the nearby anatomical structures (13.2%). Oral and maxillofacial surgery departments accounted for the highest percentage of referrals (36.1%), followed by periodontology (20.5%). Postgraduate students had the highest number of referral requests and most evaluations (54.6%) had a limited field of view. Although periodontics and oral surgeons are the most likely to use CBCT, it appears that most specialties also need to use it. The most common reason for CBCT referrals was implant site evaluation.

Keywords: Cone-beam computed tomography (CBCT), Implant, Oral surgery, Periodontics, Referral, Field of view

How to Cite This Article: Arslan ZB, Tuğutlu EC. Patterns and Indications for Cone Beam CT Referrals in Academic Dental Institutions. J Curr Res Oral Surg. 2021;1:30-6.

Introduction

One crucial instrument for dental diagnosis is the radiographic examination [1, 2]. Structure superimposition was a major limitation of traditional two-dimensional (2-D) imaging, making it impossible to precisely localize and assess the intended site. The restricted area of analysis and the potential for erratic image distortion were further drawbacks [3]. New technology is being used to increase image quality as a result of the requirement for more accurate photos [4]. Nevertheless, the more sophisticated methods offered superior imaging capabilities at the price of higher expenses and frequently higher radiation exposure [5-7]. An important achievement in this field is the creation of cone-beam computed tomography (CBCT), which produces three-dimensional pictures that are reasonably quick and easy to get and view. Compared to traditional tomography (CT) scans, they can be performed with the patient in a supine, sitting, or standing position [8] and involve less ionizing radiation exposure [9, 10]. The availability of digital formats with picture-enhancing tools, the capacity to take various measurements, and the potential need to print various photos are further benefits [3]. They have been widely used for several dental applications since their invention in the late 1990s [11, 12], including the localization of impacted teeth, the visualization of various dental and non-dental defects and anomalies, and the detailed evaluation of anatomic landmarks of the maxillofacial region and their relationship to the teeth [13, 14]. The majority of dental specialties, including orthodontics, endodontics, periodontics, dental implant implantation, and oral and maxillofacial operations, can thus benefit greatly from the use of CBCT [13].

Even though it is acknowledged and used by several dental specialties, analyzing referral trends and determining the most frequent causes of referrals is a crucial component of appropriately planning for institutional requirements, training program design, and software development. The referral trend is still unknown, though, because there aren't many papers in the area. Several other studies found that dental implant planning and site evaluation were the primary reasons for CBCT referrals, despite a Norwegian survey indicating that the biggest referral rate was for impacted teeth localization [15-17]. Furthermore, a significant amount of knowledge and service use was found among other specialists [18, 19], which merits comparison between them directly. The recommendation may also be influenced by the type of clinic or institution [15, 17], the experience and rank of the referring dentist [15, 17], the machine's availability, and the intervention's cost [20].

The purpose of this study was to determine the cause of CBCT referrals in a university setting and to examine the traits of the dentists who made the referrals.

Materials and Methods

This study was performed at King Saud University, College of Dentistry, with the ethical approval of the scientific committee. Referral forms for CBCT extending from January 2016 to February 2021 were collected from the radiology department. The forms were manually searched, and a systematic sampling technique was utilized to select referrals for inclusion in the research. The data for each selected patient were collected from the manual form. If the selected form had any missing or unclear information, the patient's electronic file was then evaluated for clarification.

Three investigators (S.A., A.M., and R.A.) performed the manual search, recording the patient’s demographic data (gender and age), the reason for referral for CBCT evaluation, the requested field of study, as well as information about the referring dentist, including his/her specialty, rank, and years of experience.

There are different clinical specialties in the university in addition to the general undergraduate dental clinics. The specialties include Prosthodontics (Prostho), Restorative dentistry (Resto), Endodontics (Endo), Periodontics (Perio), Oral and Maxillofacial Surgery (OMFS), Oral Medicine, Diagnostic oral science /radiology, Orthodontics (Ortho), and Pedodontics (Pedo). Within each specialty, there are different levels of clinicians, including students in the postgraduate specialty programs, board residents, faculty members, and consultants with different years of experience (divided into those with less than ten years in practice (< 10 years), and those with more than ten years of experience (> 10 years).

The reason for referral was categorized into implant site assessment for implant treatment planning, evaluation of impacted teeth, root proximity to anatomic landmarks (nerves or sinus), endodontic evaluation (search for an additional canal, root fracture/perforation/crack, broken instrument, as well as others), orthodontic treatment planning, pre-orthognathic surgery evaluation, post-surgical evaluation, fracture in the jaws or teeth, temporomandibular joint (TMJ) evaluation, lesion and infection evaluation, periodontic reasons, ankylosis, supernumerary teeth evaluation, and infection examination.

The machine used for image acquisition was ProMax 3D Mid, Planmeca, USA.

Statistical analyses

The baseline characteristics of the sample were presented using descriptive statistics and cross-tabulations, and the effect of cluster-level characteristics (age and gender, specialty, person requested, and field of view) on the documented reasons for referral (reason of GBCT) was determined using stepwise linear regression models and the Pearson chi-square test or Fisher exact test as appropriate.

Predictors were added one at a time for both outcomes under investigation, and they were kept in the final model if the P-value was less than 0.05. The predetermined threshold for statistical significance was set at $P \leq 0.05$. Software called SPSS Version 25 was used to conduct statistical analysis.

Results and Discussion

During the inquiry, every CBCT patient referral was examined. 546 referral forms made up the final sample, and there were somewhat more female patients than male patients (52.5% vs. 47.5%). The patient's mean age was 37.5 years old on average (± 15.6 years). There was just one patient older than 81 years, and only 1.28% of the patients in this group were younger than 10 years. The oldest patient, who was 82 years old, was referred for a dental implant site evaluation, while the youngest, who was seven years old, was referred for an examination of delayed eruption of incisors because of the existence of a supernumerary tooth. 28.75% of the patients were between the ages of 21 and 30 years **(Figure 1)**. Assessment of the implant site was the most frequent cause of CBCT referrals (n = 255, 46.7%). Lesion inspection (n = 54, 9.9%), endodontic

evaluation (n = 47, 8.6%), impaction (n = 45, 8.2%), assessment of root closeness to neighboring anatomic structures (n = 72, 13.2%), and other causes (n = 73, 13.4%) came next **(Figure 2)**.

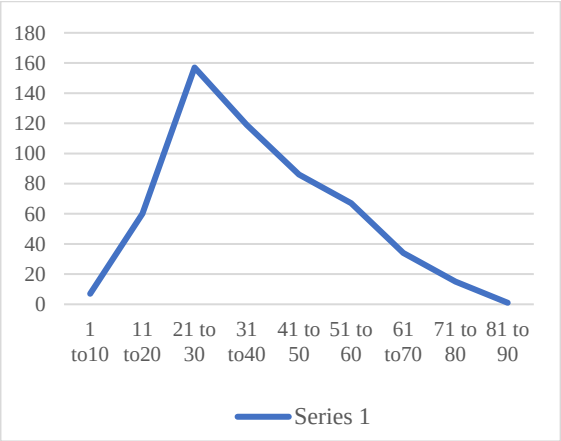

Figure 1. Frequency of the referral by age group

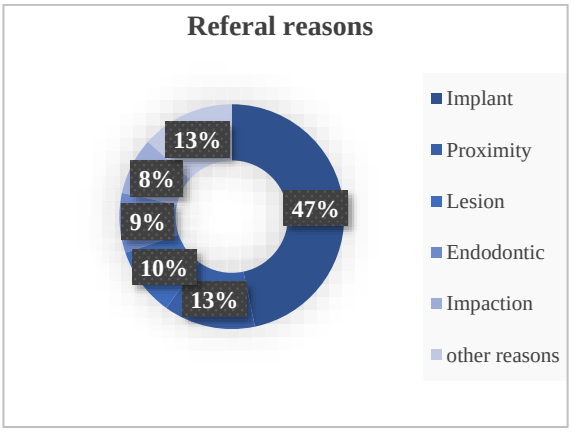

Figure 2. Percentage of referral reasons

The following was the formulation of the specialty/department that made the referral: oral surgery (36.1%) accounted for the largest percentage of referrals, followed by periodontics (20.5%), endodontics, and prosthodontics (9.5% and 9.2%, respectively) **(Table 1)**.

Postgraduate students made the majority of referral requests (41%), followed by faculty and consultants. The more experienced faculty and consultants made slightly fewer referrals than the group with fewer years of experience (24.2% vs. 26.7%), respectively, with no statistically significant difference. Undergraduate students only made a small number of referrals (44/546, 8.1%) **(Table 1 and Figure 3)**.

Table 1. Characteristics of the referring dentist

		Frequency	%
Specialty	Oral surgery	197	36.1
	Perio	112	20.5
	Endo	52	9.5
	Pros	50	9.2
	Ortho	41	7.5
	Resto	39	7.1
	Undergrad	36	6.6
	Dx\radio	13	2.4
	Oral med	4	0.7
	Pedo	2	0.4
Total		546	100

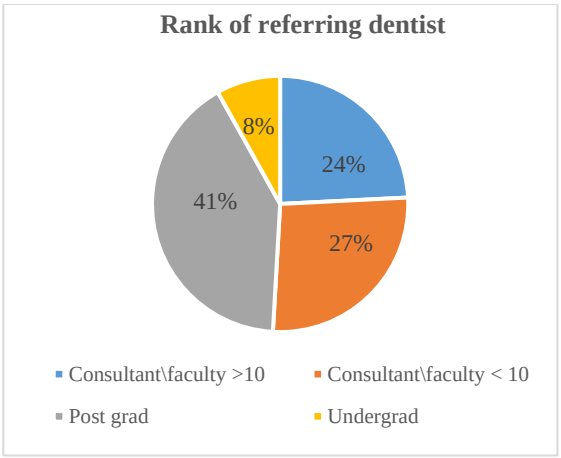

Figure 3. The rank of referring dentist

The bulk of CBCT scans for implant site evaluation was performed on patients aged 31-40 years, as opposed to those who were mostly 21-30 years old for proximity to the anatomical structures (24% vs. 65%; P < .000) **(Table 2)**.

The specialty with a CBCT explanation also showed a similar correlation. About 96 instances (36.6%) were referred by the periodontist for implant-related causes, while 61 cases (61/72, 84.7%; P < .000) were referred by oral surgery specialists **(Figure 4)**.

Table 2. Age distribution for the reason of referral

		Age									
		1-10 years	11-20 years	21-30 years	31-40 years	41-50 years	51-60 years	61-70 years	71-80 years	81-90 years	Total
Reason	Implant	0	5	36	61	58	52	28	14	1	255
	Proximity	0	6	47	14	4	0	1	0	0	72
	Lesion	2	6	19	12	4	7	4	0	0	54

Endodontic evaluation	0	1	15	13	10	8	0	0	0	47
Impaction	2	26	12	5	0	0	0	0	0	45
Other reasons	3	16	28	14	10	0	1	1	10	73
Total	7	60	157	119	86	67	34	15	1	546

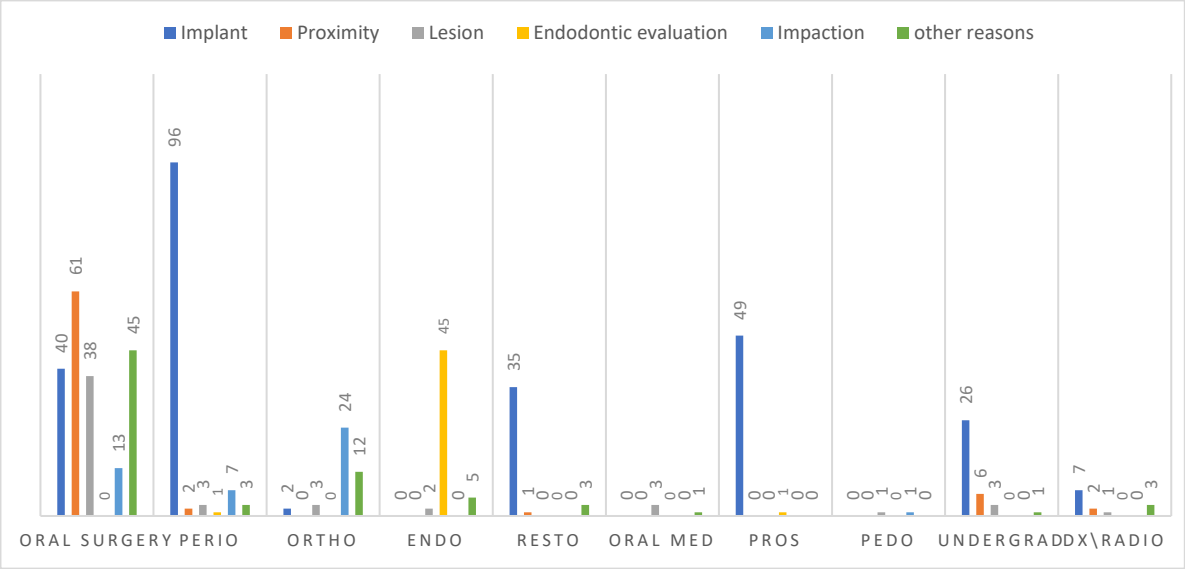

Figure 4. Referrals according to referring dental specialists

The limited field of view (FOV) was chosen for the great majority of CBCT referrals for implant-related reasons (54.6%), whereas full vision was chosen for 7% of referrals. Only two instances were sent for evaluation of the temporomandibular joint (TMJ). The impact of cluster-level factors (age and gender, specialty, person sought, and field of view) on the recorded reasons for referral (Reason of CBCT) was determined using stepwise linear regression models. Age and specialty had a major influence on the CBCT request's justification. These factors account for 25.6% of the variation in the CBCT request **(Table 3)**.

Table 3. Model summary of the significant impact of age and specialty on the reason for CBCT request

Model	R	R square	Adjusted R square	Std. error of the estimate	Change statistics				
					R Square change	F change	df1	df2	Sig. F change
1	.470[a]	0.221	0.219	3.16129	0.221	154.089	1	544	0.000
2	.506[b]	0.256	0.253	3.09162	0.035	25.795	1	543	0.000

a. Predictors: (Constant), age

b. Predictors: (Constant), age, specialty

Because of its 3-dimensional representation, image quality, speed of acquisition, and very low radiation dose when compared to traditional CT, cone beam computed tomography is a significant advancement in diagnostic imaging [9, 10]. However, a thorough assessment of the necessity of their use is necessary due to their high cost and increased radiation exposure when compared to traditional 2-D radiography modalities [8, 21, 22]. Various associations have made an effort to release recommendations with precise suggestions for their use [23-28].

The purpose of the current study was to assess the CBCT referral trends within a university. The existence of the machine within the same building, as well as the free provision of service, make this unusual. According to a study, doctors who have the device installed at the precise site of their daily practice are more likely to refer patients for CBCT than those who do not [20].

To prevent human bias and pick the number of patients based on the referral specialty, a systematic sampling technique was used to guarantee a representative sample with fair comparison among groups.

The patient's average age was 37.5 years, which was extremely similar to what Warhekar *et al*. [16] found.

Few children under the age of 10 years were included in the sample, and there was just one patient over the age of 81 years. This is explained by the fact that our institution specializes in general dentistry, and younger patients as well as those who are disabled or medically fragile and have more advanced lesions were directed to the main hospital. There is a common tendency among pediatric dentists to send their patients for CBCT assessments less frequently [16, 17, 29, 30]. Additionally, older age groups tended to favor CBCT less [16].

In this project, the primary justification for CBCT referrals was dental implant site assessment. The great long-term success and survival rates of dental implants have made them the standard of care [31–35]. Every year, a significant number of implants are placed internationally, and the market for dental implants is expanding globally [36]. Several studies in Saudi Arabia found a significant incidence of tooth loss, despite the lack of precise data on the annual number of implants implanted [37, 38]. As a result, more people require dental work. Depending on the study population chosen, awareness of dental implants as a treatment option was also comparatively high to acceptable [39-41].

Those variables contribute to a significant percentage of individuals seeking implant treatment. Clinicians are also encouraged to explore safer solutions by asking three-dimensional site examination rather than freehand implant insertion because of the frequently complex scenario for the patient seeking treatment and the facility's free presence.

The majority of other study findings have been impacted by the fact that dental implants were the primary reason for referral. The majority of implant referrals involved patients in their 30s to 50s, which is partially explained by the younger people's higher educational attainment and self-esteem issues as well as the institutional policy that chooses simpler cases for the teaching process. After lesion evaluation, endodontic evaluation, and impaction, the second most frequent reason for referral was the assessment of the teeth's closeness to anatomical structures. In contrast to prior research, where impaction was the second most frequent reason for referral, this finding [15, 16].

In line with previous studies, the oral surgery department was found to make the highest use of the services [16, 17]. Periodontists came next, a finding that can once more be explained by the fact that surgical implant placement is mostly handled by those specialties and that dental implant site review is the most frequent reason for referral. This finding was reported by Jadu and Jan [17]. Their referrals to endodontists and orthodontics were extremely close.

According to the literature, endodontists preferred to use pictures mostly when surgical endodontic therapy was planned, whereas orthodontists were primarily referred for the examination of impaction and cleft instances [18, 19].

The imaged volume is described by the field of view (FOV), which is commonly classified as limited (less than 8 cm), medium (between 8 and 15 cm), and large (more than 15 cm) [3]. The narrow field of view (FOV) was chosen by the majority of referrals. Higher image quality and lower radiation dosages are reported to result from limited FOV [3]. The accurate FOV decision is primarily based on the clarity of written referrals [42].

Postgraduate students and residents made the most requests, followed by faculty and specialists, and undergraduate students made the fewest. This result ran counter to the Norwegian study's findings [15], which showed that the biggest group requesting the service was specialists. The institution's status as an educational setting, where many postgraduate students practice, helps to explain this.

Conclusion

Cone-beam computed tomography (CBCT) is a crucial diagnostic technology used by the majority of dental specialties due to its ease and many benefits. The modality seems to be especially significant for implant site assessment and postgraduate students. These results ought to be taken into account while creating the training program and when attempting to expand or relocate the institution.

Acknowledgments: None

Conflict of Interest: None

Financial Support: None

Ethics Statement: This study was part of a group of studies approved by the Institutional Review Board at King Saud University, Project no. E-20-4695.

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