

REASON FOR REFERRAL FOR CONE BEAM COMPUTED TOMOGRAPHY IN AN ACADEMIC SETTING

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ABSTRACT

Cone beam radiography represents an essential tool for dental diagnostics that is utilized by most dental specialties. This study aims to evaluate the reason for referral for Cone-beam computed tomography (CBCT) evaluation in a university-based setting, along with characteristics of the referring dentists. A total of 546 referral forms was selected through systematic sampling technique, and different factors were recorded, including patient-related factors (age, gender), the reason for referral, the field of view, as well as referring dentist-related factors (specialty, experience). The mean age of the patients was 37.5 years. The most recorded reason for referral was implant site assessment (46.7%), followed by evaluation of root proximity to the adjacent anatomic structures (13.2%). The highest number of referrals came from the oral and maxillofacial surgery departments (36.1%), followed by periodontology (20.5%). Most referrals were requested by postgraduate students, and most evaluations involved a narrow field of view (54.6%). The use of CBCT appears to be needed by most specialties, despite a predominance of use by oral surgeons and periodontics. Implant site assessment represented the most common reason for the referral for CBCT.

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

Introduction

The radiographic examination represents an important tool for dental diagnostics [1, 2]. A significant drawback for the conventional two-dimensional (2-D) imaging was structure superimposition, preventing the accurate localization and evaluation of the desired location. Another disadvantage was the limited field of examination and the possible and unpredictable image distortion [3]. The need for more accurate images has led to the application of new technology for the improvement of image quality [4]. However, the more advanced techniques provided better imaging qualities at the expense of increased cost and often radiation exposure [5-7]. The development of cone-beam computed tomography (CBCT) represents a significant advancement in this area, providing three-dimensional images that are relatively fast and convenient to acquire and display. They can be obtained with the patient in a supine, seated, or standing position [8], with less exposure for ionizing radiation than the conventional tomography (CT scans) [9, 10]. Additional advantages include the availability of digital formats with image enhancement tools, with the possibility of making different measurements along with possible printing of different images required [3].

Since their invention during the late 1990s [11, 12], they were widely used for several dental applications involving the detailed evaluation of anatomic landmarks of the maxillofacial region and their relation to the teeth, the visualization of different dental and non-dental defects and anomalies, as well as the localization of impacted teeth [13,

14]. Accordingly, CBCT has broad potential for applications for most dental specialties, including orthodontics, endodontics, periodontics, dental implant placement, and oral and maxillofacial surgeries [13].

Despite being recognized and utilized by different dental specialties, the evaluation of referral patterns with identification of the most common reasons for referral represents essential features for the proper planning for institutional needs, training program structure, and software development. However, due to the limited number of papers in the area, the referral pattern remains unclear. Although a Norwegian survey reported that the highest referral rate was for impacted teeth localization [15], dental implant planning and site evaluation was reported to be the main reason for CBCT referrals in several other studies [16, 17]. Additionally, a valuable amount of knowledge and service utilization was detected among other specialists [18, 19], which deserves direct comparison among them. Other factors that may affect the referral include types of clinics/institutions [15, 17], the rank and experience of the referring dentist [15, 17], the availability of the machine, and the cost of the intervention [20].

This study aimed to identify the reason for referral for CBCT in a university-based setting, along with analyzing the characteristics of the referring dentists.

Materials and Methods

This study was performed in King Saud University, college of dentistry, with the ethical approval of the scientific committee. Referral forms for CBCT extending from January 2016 till 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 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 (Prosthodontics), 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

Descriptive statistics and cross-tabulations were performed to present baseline characteristics of the sample. The Pearson chi-square test or the Fisher exact test was used as appropriate. Stepwise linear regression models were built to identify the effect of cluster-level (age and sex, specialty, person requested, and Field of view) characteristics on the documented reasons for referral (Reason of GBCT).

For both examined outcomes, predictors were inserted sequentially one at a time and retained in the final model if

P, 0.05. The level of statistical significance was prespecified at P≤0.05. Statistical analyses were performed with SPSS Version 25 software.

Results and Discussion

All CBCT patient referrals during the investigation period were screened. The final sample consisted of 546 referral forms, with a slight preponderance of female patients compared to male patients (52.5% Vs. 47.5%). The mean age of the patients was 37.5 years (±15.6 years). Only one patient over eighty-one years was found, with few patients younger than ten years present in this sample (1.28%). The youngest patient was seven years old and was referred for the evaluation of delayed eruption of incisors due to the presence of supernumerary tooth, while the eldest was 82 years old and referred for dental implant site evaluation. The majority of patients were between 21-30 years old (28.75%) (Figure 1).

The most common reasons for CBCT referral was implant site assessment (n=255,46.7%). This was followed by evaluation of root proximity to adjacent anatomic structures (n=72,13.2%), lesion examination (n=54, 9.9%), endodontic evaluation (n=47, 8.6%), impaction (n=45, 8.2%) and other reasons (n=73, 13.4%) (Figure 2).

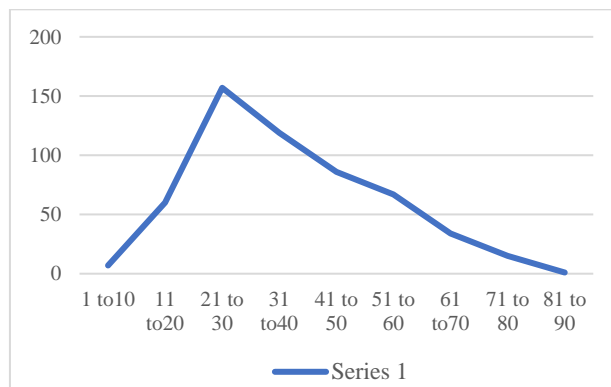


Figure 1. Frequency of the referral by age group

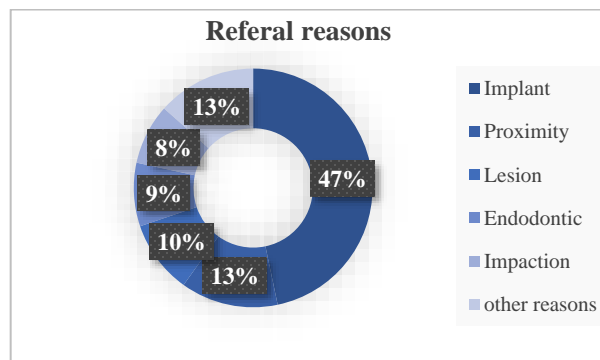


Figure 2. Percentage of referral reasons

The specialty/ department that issued the referral was formulated as follows: the most significant number of

referrals came from the oral surgery department (36.1%), followed by periodontics (20.5%), endodontics, and prosthodontics (9.5% and 9.2% respectively)—**Table 1**.

Most of the referrals were requested by postgraduate students (41%), followed by faculty members and consultants, with slightly lower referral rates done by the more experienced faculties/consultants compared to the group with fewer years of experience (24.2% Vs. 26.7%), respectively with no statistical significance. Only a few referrals were issued by undergraduate students (44/546, 8.1%) (**Table 1, Figure 3**).

Table 1. Characteristics of the referring dentist

	Frequency	Percent (%)
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

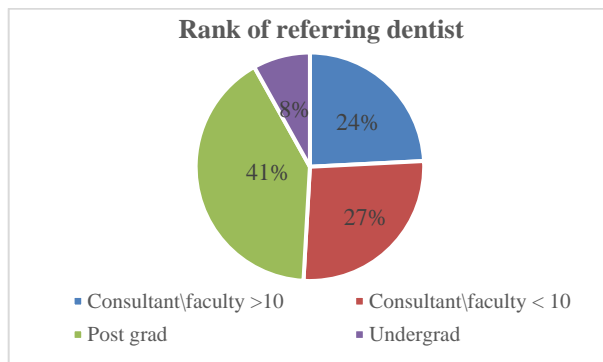


Figure 3. Rank of referring dentist

The vast majority of CBCT scanned for implant site assessment were for age 31 to 40 years compared with proximity to the anatomic structures that was mainly done for patients 21 to 30 years old (24% Versus 65%; $P < .000$) (**Table 2**).

A similar association was also recorded for specialty with a CBCT reason. The periodontist referred around 96 cases for implant-related reasons (36.6%), compared with 61 cases referred by oral surgery specialists (61/72, 84.7%; $P < .000$) (**Figure 4**).

Table 2. Age distribution for the reason of referral

Reason	Age										Total
	from 1 to 10 years	from 11 to 20 years	from 21 to 30 years	from 31 to 40 years	from 41 to 50 years	from 51 to 60 years	from 61 to 70 years	from 71 to 80 years	from 81 to 90 years		
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	

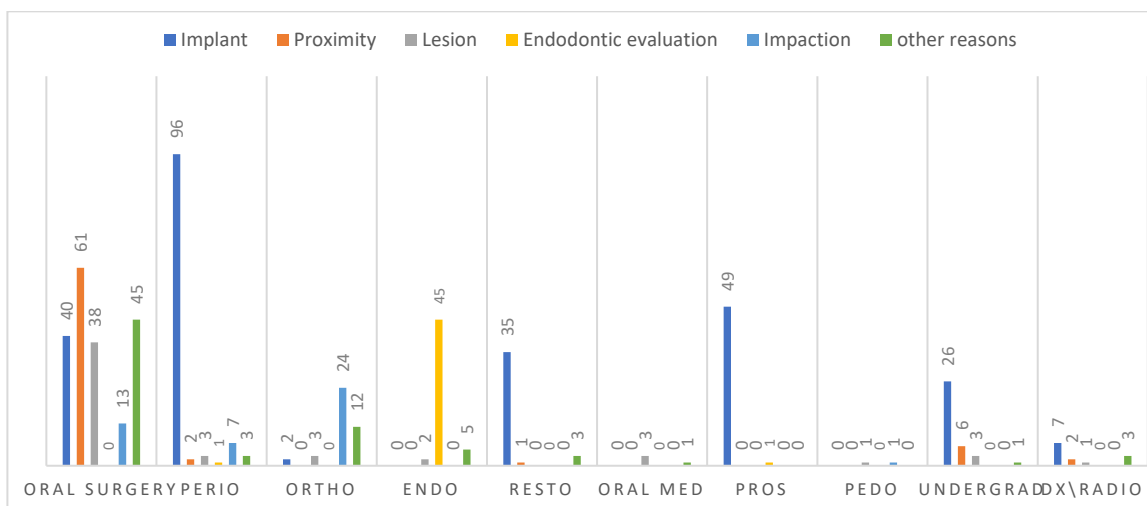


Figure 4. Referrals according to referring dental specialists

The vast majority of CBCT referrals for implant reasons selected the narrow field of view (FOV) (54.6%), while full view represented 7 % of the referrals. Only 2 cases were referred for temporomandibular joint assessment (TMJ).

Stepwise linear regression models were built to identify the effect of cluster-level (age and sex, specialty, person

requested, and Field of view) characteristics on the documented reasons for referral (Reason of CBCT).

There was a significant impact of age and specialty on the reason for the CBCT request. These variables can explain 25.6% of the change that happens in the CBCT request (**Table 3**).

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

Cone Beam computed tomography represents a major advance in diagnostic imaging, thanks to its 3-dimensional representation, image quality, acquisition speed, and relatively low radiation dose compared to conventional CT [9, 10]. However, the high cost and higher radiation exposure compared to conventional 2-D radiographic modalities necessitate careful evaluation for the actual need for their use [8, 21, 22]. Different societies have attempted to announce guidelines containing specific indications for their utilization [23-28].

The current study aimed at evaluating the CBCT referral patterns in an academic institution. The uniqueness of this is the presence of the machine within the same building and the provision of service free of charge. A study found the referral for CBCT to be more frequent by the clinicians who have the device installed in the exact location of their daily practice than by those who do not have it [20]. Another study found the ownership of insurance policies to increase the

To ensure a representative sample with fair comparison among groups, a systematic sampling technique was utilized, hereby avoiding human bias and selecting the number of patients following the referring specialty.

The mean age of the patients was 37.5, which was very close to the findings of Warhekar *et al.* [16]. Only one single patient over the age of 81 was present in the sample, with few patients younger than ten years of age. This can be justified by the specialty of our institution for general dental care, where younger patients, and medically compromised/or disabled patients with more advanced lesions, were referred to the main hospital. A general trend was found among pediatric dentists to less often refer their patients for CBCT evaluations [16, 17, 29, 30]. Also, CBCT was generally less preferred among the older age groups [16].

In this project, dental implant site assessment represented the main reason for referral for CBCT. Dental implants are becoming a standard of care, with high long-term success and survival rates [31-35]. A large number of implants are placed yearly worldwide, and dental implants are presenting a globally growing market [36]. In Saudi Arabia, despite the absence of clear statistics on the number of implants placed per year, the percentage of tooth loss was high in several studies [37, 38]. Thus, the need for teeth replacement is increasing. Knowledge about dental-implant as a treatment option was also relatively high to acceptable, depending on the selected study population [39-41].

Those factors lead to a high number of patients seeking implant treatment. Additionally, the often-complicated situation for the patient seeking treatment and the facility's presence free of charge encourages the clinicians to seek the safer options requesting three-dimensional site evaluation rather than freehand implant placement.

The fact that dental implants constituted the main reason for referral has impacted most other study findings. Most implant referrals involved patients in their 30s to 50s, which can be justified partly by the higher educational level and self-esteem concerns of the younger individuals and by the institutional regulation for selecting more straightforward cases for the teaching process. The evaluation of teeth proximity to anatomical structures constituted the second most common reason for referral, followed by lesion evaluation, endodontic evaluation, and impaction. This finding differed from other studies where impaction was the second most common cause for referral [15, 16].

The oral surgery department was found to utilize the serves the most, which was following the other studies [16, 17]. This was followed by periodontists, a finding that again can be explained by the dental implant site evaluation being the most common reason for referral and by having surgical

implant placement mainly performed by those specialties. This finding was following Jadu and Jan in 2019 [17]. Orthodontists and endodontists followed them with a very close number of referrals. In the literature, the main reason for orthodontist referrals was the evaluation of impaction and cleft cases [19], while endodontists tended to use the images mainly when surgical endodontic therapy was planned [18].

The field of view (FOV) describes the imaged volume and can be generally divided into limited FOV (less than 8 cm), medium FOV (8 to 15 cm), and large FOV (greater than 15 cm) [3]. Most referrals selected the limited field of view (FOV). Limited FOV is known to use smaller radiation doses and produce higher image quality [3]. The correct decision of FOV is highly dependent on the clarity of written referrals [42].

Most requests were placed by postgraduate students/residents, followed by specialist/faculty, and the least was by undergraduate students. This finding was contrary to the findings of the Norwegian study [15], where specialists were the highest group requesting the service. This can be explained by the nature of the institution being an educational setting with a large number of postgraduate students practicing there.

Conclusion

Because of its convenience and several advantages, Cone-beam computed tomography (CBCT) represents an essential diagnostic tool utilized by most dental specialties. The modality appears of additional importance to the postgraduate students and implant site assessment. Those findings should be considered during the development of the training curriculum and institutional expansion/relocation attempts.

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