

Incidental Findings on Cone Beam Computed Tomography and Reasons for Referral by Dental Practitioners in Indore City (M.P)

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ABSTRACT

Introduction: Cone beam computed tomography is a new diagnostic innovation to dental imaging. Despite the use of CBCT in oral and maxillofacial imaging, reports on its use either by individual practitioners or referral patterns to CBCT centers is lacking. Hence, a study was conducted to determine incidental findings on CBCT and reasons for referral by dental practitioners in Indore city.

Materials and Methods: A retrospective analysis of 795 records that were referred for CBCT imaging at Institutional and Oracal CBCT Centre, Indore was undertaken. Referrals from both within and outside institution, as well as from private practitioners were considered. The reason for CBCT referral, provision diagnosis, final diagnosis and any incidental diagnosis were recorded.

Results: This retrospective chart audit revealed that 56.7 % were male and 43.3% were females. Greatest source of patients

was referred by oral surgeons (21.9%) followed by oral and maxillofacial radiologist (14.2%) and prosthodontist (9.3%). The most common reason for referral was for implant analysis (24.2%) and the most common incidental finding diagnosed by CBCT was oral malignancies.

Conclusion: In Institutional set-up, CBCT referrals were mostly for the reason of planning implant placement followed by trauma whereas private practitioners used CBCT mostly for implant placement followed by impaction. CBCT was being utilized more by Oral surgeons in private sector whereas it in an Institutional setup majority of referrals from Department of Oral Diagnosis and Radiology. Findings that were most commonly diagnosed incidentally on CBCT were Orofacial malignancies followed maxillary sinus pathologies.

Keywords: CBCT, Referral pattern, Incidental finding

INTRODUCTION

Computed tomography (CT) is the cornerstone of modern medical radiology [1]. CBCT, a revolutionary imaging technique invented as a result of advances in computer and electronic technology [2]. Medical CT imaging is growing at an estimated annual rate of 15–20%, primarily due to its utility and availability [1]. Cone beam CT (CBCT), which is a relatively recent scanning technology in dentistry, provides images comparable to medical CT at reduced costs and radiation doses [3]. The radiation dose to the patient with CBCT is 40 % lower than that of multi-slice CT dose but is 3-7 times more than conventional panoramic radiograph exposure dose. CBCT has been considered the examination of choice in many instances, since it provides high resolution imaging, diagnostic reliability and risk benefit assessment [4].

The cone beam technology has been given several names including computerized axial tomography, computerized reconstruction tomography, computed tomographic scanning, cone-beam volumetric tomography and cone-beam volumetric imaging. Currently preferred term is Cone Beam Computed Tomography (CBCT) [5]. Alan Cormack in the 1950s and 1960s developed image reconstruction mathematics of medical CT scanner which was subsequently patented by Hounsfield [6]. In 1972 Godfrey Hounsfield announced the invention of a technique, which he referred to as computerized axial transverse scanning [7]. Since the late 1990s CBCT devices have been designed specifically for dentomaxillofacial imaging (Arai et al., 1999, Mozzo et al., 1998) [6]. Due to rapid commercialization of CBCT technology, its access by dental practitioner will increase. CBCT imaging provides high-contrast spatial resolution and reported

radiation dose equivalent to that needed for 4 to 15 panoramic radiographs [8].

At present, reports on the use of CBCT either by individual practitioners in dental practice or referral patterns to CBCT centers is lacking. There is relatively little published research on incidental findings on CBCT images. Hence, we conducted a study with an aim to describe the patterns of referral and prescription of dental practitioners in the use of CBCT imaging, and to identify the type and rate of incidental findings on referred CBCT scans by dental practitioners in Indore city.

MATERIALS AND METHODS

The study sample (n = 795) consisted of radiologic reports of patients that were referred for CBCT imaging to the Department of Oral and Maxillofacial Radiology at a private dental institution and Oracal CBCT Diagnostics, Indore. Patients were referred for CBCT imaging from both within the institution and from private practitioners. A retrospective audit of the CBCT radiologic report database was performed from September 2012 till March 2014 (Oracal CBCT) and April 2013 to March 2014 (Private dental Institute). Permissions were obtained from the concerned authorities of institution and private CBCT centre.

The data collection consisted of category of practitioner, specialty availing the CBCT services, reason for referral, radiological assessments, provisional diagnosis, differential diagnosis if any, CBCT interpretations and incidental findings. Medical consultants referred for CBCT diagnosis were also considered. To assess the pattern of utilization of CBCT, the referrals were broadly classified into two

major categories: Diagnostic scan and treatment planning scan. All referral which requested CBCT interpretation in diagnosis of any lesion or pathology were considered under diagnostic scans. Those referral requesting CBCT analysis for carrying out treatment were considered treatments planning scans. Any finding on the CBCT interpretation other than the area of concern for which the patient referred was recorded as incidental finding.

STATISTICAL ANALYSIS

Data collected was entered into Microsoft excel and descriptive analysis to know the frequencies was performed using Statistical Package for Social Sciences (SPSS) version 16.5. Chi-square test was employed to compare the referral pattern in institution and private centre.

RESULTS

A total of 795 patients referred for CBCT. Out of this 451(56.7%) were males and 344 (43.3%) were females. The mean age of patients referred for CBCT was 37.20 ± 16.09 y. Most frequently referred patient age groups were the 21-30 age group (24%) followed by 31-40 age group (19.7%).The CBCT diagnosis was least preferred in older age group [Table/Fig-1].

General Private Practitioners (35.6%) constituted the largest group who referred patients for CBCT diagnosis. Among the specialist and consultants, Oral surgeons (21.9%) and Oral radiologist (14.2%) were the major groups referring patients to CBCT followed by Prosthodontists (9.3%) and Orthodontists (7.8%). When these referrals were considered separately for the institutional CBCT and private CBCT centre, a different pattern was seen. CBCT was being utilized more by the general practitioners (40.6%) in private sector

Demographic Variables		Private CBCT Centre n (%)	Institutional CBCT Centre n (%)	Total n (%)
Gender	Male	329 (56.4)	122 (57.5)	451 (56.7)
	Female	254 (43.6)	90 (42.5)	344 (43.3)
Total		583 (100)	212 (100)	795 (100)
Age group	1-10	11 (1.9)	7 (3.3)	18 (2.3)
	11-20	90 (15.4)	28 (13.2)	118 (14.8)
	21-30	129 (22.1)	62 (29.2)	191 (24.0)
	31-40	117 (20.1)	40 (18.9)	157 (19.7)
	41-50	109 (18.7)	29 (13.7)	138 (17.4)
	51-60	67 (11.5)	28 (13.2)	95 (11.9)
	61-70	51 (8.7)	16 (7.5)	67 (8.4)
71-80		9 (1.5)	2 (1.0)	11 (1.4)
Total		583 (100)	212 (100)	795 (100)

[Table/Fig-1]: Frequency distribution by Demographic variables

Specialities	Private CBCT Centre n (%)	Institutional CBCT Centre n (%)	Total n (%)
Oral Surgery	138 (23.7)	36 (17.7)	174 (21.9)
Pedodontics	7 (1.2)	2 (0.9)	9 (1.1)
Orthodontics	56 (9.6)	6 (2.8)	62 (7.8)
Prosthodontics	59 (10.1)	15(7.1)	74(9.3)
Periodontics	19 (3.3)	13(6.1)	32(4.0)
Conservative dentistry	24 (4.1)	20(9.4)	44(5.5)
Oral diagnosis	40(6.9)	73(34.4)	113(14.2)
General practioners	237(40.6)	46(21.7)	283(35.6)
ENT, Oral Pathology Oncologist, Public Health Dentist	3(0.6)	1(0.5)	4(0.4)
All Specialities	583 (100)	212 (100)	795 (100)

[Table/Fig-2]: The CBCT referrals by various specialities

Reason For Referral		Private CBCT Centre n (%)	Institutional CBCT Centre n (%)	Chi square test
TREATMENT PLANNING	Impaction	74 (26.1)	11 (12.1)	$\chi^2=18.9$ df=8 p=0.015 Significant
	Implant Placement	144 (50.7)	48 (52.7)	
	Trauma/fracture	41 (14.4)	13 (14.3)	
	Developmental disturbances and Cleft Palate	4 (1.4)	2 (2.2)	
	Cephalometric Analysis	2 (0.7)	3 (3.3)	
	Canal Evaluation	8 (2.8)	5 (5.5)	
	Trismus	3 (1.1)	4 (4.4)	
	Endodontic Complications	0 (0)	1 (1.1)	
	Postsurgical Evaluation	8 (2.8)	4 (4.4)	
	Total	284 (100)	91(100)	

[Table/Fig-3]: Reasons for referral for CBCT based on treatment planning

Reason for referral		Private CBCT Centre n (%)	Institutional CBCT Centre n (%)	Chi square test
DIAGNOSTIC SCAN	Swelling	67 (22.4)	21 (17.4)	χ^2 test = 13.82 df = 9 p > 0.05 Non-significant
	Facial Pain	9 (3)	5(4.1)	
	Teeth related pain	35 (11.7)	29 (24)	
	Maxillary Pathology	56 (18.7)	24 (19.8)	
	Mandibular Pathology	52 (17.4)	21 (17.4)	
	Maxillary and Mandibular bone	9 (3)	3 (2.5)	
	TMJ pathology	62 (20.7)	15 (12.4)	
	Salivary gland Evaluation	5 (1.7)	1 (0.8)	
	Sinus Pathology/ Oroantral Fistula	2 (0.7)	1 (0.8)	
	Others (altered tongue sensation, periodontitis)	2(0.7)	1 (0.8)	
Total	299 (100)	121 (100)		

[Table/Fig-4]: Reasons for referral for CBCT based on Diagnostic scan

CBCT interpretation	Clinical finding of pathology involving		
	Maxillary	Mandibular	Both
Impacted teeth	2	2	-
Fracture of maxilla or mandible	4	10	1
Tooth fracture	1	2	1
No abnormality	-	1	-
Cystic lesions	21	7	1
Tumor	1	4	-
Periapical lesion	31	33	2
Temporomandibular disorder	1	-	-
Salivary gland disease	1	-	-
Giant cell, cement-osseous, fibro-osseous lesion	3	2	2
Carious pulp exposure/Irreversible pulpitis	3	1	1
Cleft palate	1	-	-
Dev. Disturbances, Abnormal tooth or root Anatomy	1	3	1
Dry socket	1	-	-
Healing fracture or wound	1	2	-
Oroantral fistula/Max. Sinus pathology	1	-	-
Others like exostosis, malignancy, neuropathy , pericoronitis, phebolith, hematoma	7	6	3
Total	80	73	12

[Table/Fig-5]: Radiographic CBCT interpretations of cases referred on the basis of clinical finding of pathology involving Oro-facial region

Findings seen on CBCT	Frequency	Percent
No incidental findings or Findings related to primary area of concern	738	92.8
Malignancy	11	1.4
Maxillary sinus pathology	10	1.3
Ameloblastoma	6	0.8
Odontogenic keratocyst	4	0.5
Deviated nasal septum	3	0.4
Giant cell granuloma	3	0.4
Sialolith	2	0.3
Hyperparathyroidism or multiple myeloma	2	0.3
Fibrous dysplasia	1	0.1
Elys cyst	1	0.1
Fracture of anterior nasal spine	1	0.1
Myositis ossificance	1	0.1
Neuropathy	1	0.1
Elongated styloid process	1	0.1
Mucormycosis	1	0.1
Dens Evaginatus	1	0.1
Fused teeth	1	0.1
Elongated stylomandibular ligament	1	0.1
Condylar hyperplasia	1	0.1
Mucocele	1	0.1
Benign Cementoblastoma	1	0.1
Ludwig Angina	1	0.1
Arthocentesis	1	0.1
Myofacial Pain Dysfunction Syndrome	1	0.1
Total	795	100.0

[Table/Fig-6]: Incidental findings on CBCT scan

whereas it was majorly used by oral and maxillofacial radiologist (34.4%) in an institutional setup [Table/Fig-2].

The reasons for referral of patients for CBCT scan varied significantly ($p < 0.05$) [Table/Fig-3]. For the convenience, all these referrals were broadly classified as diagnostic scan and treatment plan scans. Among all the treatment planning scans, CBCT referrals were done commonly for planning implant placement in both institutional setup (52.7%) and private setup (50.7%). In private setup, the other reasons for referral was for impaction (26.1%) followed by Trauma and fracture (14.4%). Whereas, in institutional centre trauma (14.3%) precedes impaction (12.1%). The lesser reasons for a treatment planning scan included cleft, canal evaluation, post-surgical evaluation, trismus and Cephalometric evaluation.

There were differences in reasons for CBCT referrals when diagnostic scans were considered. The CBCT referral in private setup was made for the reasons of swelling (22.4%) and TMJ pathology (20.7%) followed by pathology related to jaws [Table/Fig-4]. The reasons for referral in an institutional centre was more in circumstances of tooth pain (24%) followed by pathology of jaws (19.8%), swelling and TMJ pathology (17.4%). However, these differences were not statistically significant (p -value ≥ 0.05).

To know the in-depth knowledge of referral related to clinical findings of pathology involving the jaws, an assessment of radiographic interpretations on these referrals was carried out. About 30% of cases of maxillary or mandibular pathology the radiographic finding were periapical lesion [Table/Fig-5]. Cystic lesions (21%) were common in maxillary pathology referrals. Fracture was seen in 10% of cases of mandibular pathology.

Out of the 795 total cases that were referred, 738 (92.8%) showed findings in the primary regions of interest. The findings other than area of concern are recorded as incidental [Table/Fig-6]. The most

frequent incidental finding was orofacial malignancies (1.4%) followed by maxillary sinus pathologies (1.3%). Ameloblastoma, Keratocystic odontogenic tumour, Deviated nasal septum, Giant Cell granulomas together constitute 2.1% of the incidental findings.

DISCUSSION

The first CBCT scanner was built for angiography at Mayo in 1982 [9]. The first CBCT system became commercially available for dentomaxillofacial imaging in 2001 (New Tom QR DVT 9000; Quantitative Radiology, Verona, Italy) [10]. However, the data regarding the referral pattern and incidental finding is lacking.

In our study the mean age of patients referred for CBCT was 37.20 ± 16.09 years with predominance of males (56.7%) However in the study done by Arnheiter et al., [11] the mean age of patients referred for CBCT was 45 ± 21 y with predominance of women (62%). They reported that most referrals were from oral and maxillofacial surgeons (51%) and periodontist (17%). In our study, oral and maxillofacial surgeons (21.9%) and Oral radiologist (14.2%) were the major groups referring patients to CBCT. Oral radiologist was second most referring group because reports from institution and private centre both were taken into consideration. The majority of patients were referred for dental implant planning (40%). However this finding was in accordance with our study as CBCT referrals were done commonly for planning implant placement in both institutional set-up (52.7%) and private setup (50.7%) [11].

Brendan Fanning analysed the reason for taking CBCT images as a part of quality assurance programme in dental radiology. He concluded that Implant planning accounted for 40% of the scans taken. Twenty six percent was for endodontic lesion assessment. Impactions made up 19% in total [12].

Grondahl (2007) in Sweden reported that 40 per cent of all CBCT scans were taken for implant treatment. The relative frequency between different oral specialties was: Oral surgery (19%), Orthodontics (19%), Endodontics (17%). Least CBCT scans were taken for Temporomandibular joint (1%) and Otorhinolaryngology (2%) [13].

In all the above studies discuss Oral and Maxillofacial surgeons account for greatest number of referral for implant analysis. Reason for referring more number of patients for implant analysis as CBCT images allow more accurate and dependable views of the inter-radicular relationships than panoramic radiographs [14]. However, Lingeshwar D concluded that the final selection of imaging modalities is dependent on the operator choice based on the patient's need [15].

In our study, 92.8% showed findings in the primary regions of interest and/or outside the regions of interest and 57(7.2%) different conditions were visualized in these scans both in and outside the areas of interest. similarly other studies done by Cha et al., [16], Caglayan and Tozoglu [17] and Price et al., [18] found that incidental findings was 24.5%, 92.8% and 90.7% and respectively. The highest rate of incidental findings by Cha et al., was in the airway area (18.2%), followed by TMJ findings (3.4%), endodontic findings (1.8%), and others (1.2%) [16]. However, the most frequent incidental finding in our study was malignancies of orofacial region (1.4%) followed by maxillary sinus pathologies (1.2%). None of the studies reported oral malignancies as the most frequent incidental finding as it required histopathological confirmation. However, the study done by Uribe et al., to evaluate diagnostic accuracy of imaging methods for detection of bone tissue invasion in patients with malignancy showed sensitivity values of 91% with CBCT and specificity values of 100% with CT, MRI, CBCT [19]. Smith et al., reported that 67.5% had maxillary sinusitis diagnose incidentally. However, the findings were relatively very low in our study [20].

The reason of finding oral malignancies as the most frequent incidental finding may be the low diagnostic accuracy by private

general dental practitioners. The level of accuracy for opportunistic screening of oral pre cancer and malignant lesions reported by Seoane J et al., in Spain showed that diagnostic sensitivity of the general dental practitioners for oral cancer detection was 61.4 and specificity of 86.5. It is generally accepted that a sensitivity of agreement higher than 80% is acceptable for systematic screening of oral cancer Ikeda et al., [21].

The study done by Kondori I et al., in Brazil reported 43% of the clinical diagnoses made by the general dentists were incorrect. General dentists misdiagnosed 45.9% of the oral lesions they had biopsied, oral and maxillofacial surgeons misdiagnosed 42.8%, endodontists misdiagnosed 42.2%, and periodontists misdiagnosed 41.2%. They also reported no significant difference in the diagnostic accuracy between the general dentists and dental specialists [22]. Bacci C conducted a study in Italy to ascertain the overall accuracy of clinical diagnoses established by dentists. He reported diagnostic errors pertained to benign neoplasms was 23.8%, and for malignant neoplasms the percentage was as high as 78.9% [23].

The Sample size in our study was greater compared to the studies by Price et al, (300 cases), Caglayan and Tozoglu (207 cases), Cha et al., (500 cases), and Pette et al., (318 cases). Such a large sample provides a better clarification of the importance of reviewing CBCT scans thoroughly as significant diseases such as malignancies and also those diseases that are relatively rare are more likely to be included in the sample size, But it is less than the study done by Allareddy V (1000 Cases) [24]. One of the limitations of this study is that subjects who were radiographically diagnosed as malignancy were not compared with histopathological findings to differentiate them from any other osteolytic lesions. Areas of potential future investigation include incidental findings supported by histologic as well as radiographic findings and to study usage information and trends in order to estimate the future utilization, also to study the diagnostic accuracy of the general practitioners with members of various dental specialties.

CONCLUSION

The most common reasons for CBCT referrals was for planning implant placement, trauma and impaction in institutional set up while in private setup, the implant placement followed by impaction, trauma and fracture. When referral pattern was considered separately for institutional and private centre, CBCT was being utilized more by the general practitioners and oral Surgeons in private sector whereas it in an institutional setup the majority of referrals from the Department of Oral Diagnosis and Radiology. Findings that were most commonly diagnosed incidentally on CBCT were Orofacial malignancies followed maxillary sinus pathologies. Although oral radiologist make aware the specialist about the incidental finding and evaluate possibility of underlying disease but they have to be confirmed on the basis of histopathological findings. In addition to this there is also need for increasing diagnostic sensitivity by establishing educational interventions to help general dental practitioners gain expertise in clinical diagnosis of oral malignancies.

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