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Cone beam computed tomography (CBCT) assessment for referral reasons and impact of pre-operative CBCT in diagnosis and treatment planning in endodontics

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Abstract---Background and objectives: Cone Beam Computed tomography (CBCT) has become an important part of the diagnosis and treatment planning of various dental procedures including endodontics. Modern endodontics has become very advanced and it need very fine radiographic details which can be obtained through CBCT. The present study was carried with a purpose of evaluation of main reasons for referral of endodontic subjects for Cone Beam Computed Tomography (CBCT) and impact of preoperative CBCT over the diagnosis and treatment planning in these referred cases. Materials and methods: In this study complete case study of patients who reported for endodontic procedures were examined. From this data those cases were selected which were further referred for CBCT examination. The CBCT images were analysed and information were gathered regarding the number of patients and teeth examined with CBCT, the main purpose to refer the case for CBCT examination, whether the teeth were endodontically treated previously, if there was presence of endodontic lesion, whether symptoms were present at the time of CBCT examination, if there was change in the diagnosis and treatment planning after CBCT examination and what type of treatment was carried out for each tooth after CBCT examination. Statistical analysis was carried out with the help of Pearson Chi square test and fisher's exact test. The level of significance was adjusted at $p \leq 0.05$. Results: A total of 437 endodontic cases (215 new cases and 222 retreated cases) were selected out of which it was found that 134 patients (30.66%) were referred for CBCT examination. Planning for surgical treatment was the most common reason for referral for CBCT in 58 patients in which 68 teeth were examined. In 102 cases (64.55%) there was no major change in diagnosis after the CBCT examination while in 56 cases (34.45%) diagnosis was changed

after CBCT examination. However in most of cases (62.02%) there was major change in the treatment planning after CBCT examination. The finding was statistically significant with ($p \leq 0.05$). Conclusion: Treatment planning for endodontic surgery was the most common reason for referral of endodontic patients to CBCT examination. There was change in treatment planning in majority of the endodontic subjects referred for CBCT imaging.

Keywords--CBCT, diagnosis, endodontic cases, impact, referral, reasons treatment.

Introduction

Cone Beam Computed tomography (CBCT) has become an important part of the diagnosis and treatment planning of various dental procedures including the endodontics.¹ It is a three dimensional imaging technique which provide radiographic details in all three dimensions. The details provided by CBCT are very accurate with least distortions and magnifications.² CBCT is also helpful in providing accurate measurements of anatomical structures which further enhance the diagnosis and treatment planning. There is production of 3D images which help in educating the patients for various treatment procedures.³

Modern endodontics has become very advanced and it need very fine radiographic details which can be obtained through CBCT. There is need for proper radiographic details of root and root canals which is accurately presented by CBCT.⁴ Other endodontic treatment procedures where CBCT is very helpful is endodontic surgery. CBCT give the exact location and extent of the endodontic lesion.⁵ It give exact distance between the boundary of lesion and adjacent vital anatomical structures like mandibular canal, mandibular foramen, nasal floor, floor of maxillary sinus etc. All these information help the clinician in performing less invasive surgery.⁶ CBCT is also helpful in other complex endodontic procedures like management of resorption (internal and external) , negotiation of extra canals like MB2 canals and anatomical irregularities like pulp stone, extra root, dens evaginatus, dens invaginatus and many more.⁷

There are some disadvantages of CBCT also. The most important limitation is the high amount of ionizing radiation as compared with other conventional radiographic techniques. The excess radiation exposure may cause harmful effects for general health. Besides CBCT is costly imaging technique.^{8,9} Therefore while prescribing CBCT for any patient proper care should be taken regarding the benefits as well as disadvantages of CBCT in each case of referral. Another important factor is the presence of CBCT machine at the private dental clinic. If CBCT machine is not present at the private clinic then number of referral cases for CBCT examination is affected. All these factors are important when the referrals of endodontic cases are made for CBCT.¹⁰

Although CBCT provide important radiographic details but still there is ongoing debate regarding the impact of preoperative CBCT over the diagnosis and treatment planning in endodontic subjects. Some of the previous studies has

suggested different results over the impact of preoperative CBCT over the diagnosis in endodontic subjects. There is major change in the diagnosis in 16-62% cases after CBCT imaging according to previous studies.¹¹

Very few studies has been conducted in past to evaluate the referrals of endodontic cases for CBCT from dental set up including the percentage of cases being referred and the major reasons for the referral along with analysis of the impact of preoperative CBCT over the diagnosis and treatment planning in these referred cases.¹² Therefore the present study was carried with a purpose of evaluation of main reasons for referral of endodontic subjects for cone beam computed tomography (CBCT) and impact of CBCT in the diagnosis and treatment planning in these referred cases.

Methods and Materials

The present study was conducted at Saudident Dental speciality clinic, Khamis mushayat, Saudi Arabia. In this research complete case study of patients reporting to endodontic clinics were examined. From these patients those cases were selected which were further referred for CBCT examination. It was taken care that all cases referred for CBCT were included. Contact details were obtained of these patients along with mobile number and email address. The adult subjects and the parents of subjects less than 18 years were contacted and called to explain the study design. The subjects were given complete details of the study design along with the informed consent form. They were assured that their personal details will not be disclosed. They were asked for their consent for study and use of their radiographic images.

Once the consent was obtained then the CBCT radiographic images of the subjects were obtained from the database. They were analysed and interpreted by a two well qualified oral and maxillofacial radiologist. The complete case study of the subjects were analysed and information were gathered regarding the complete number of patients and teeth examined with CBCT, the main purpose to refer the case for CBCT examination, whether the teeth examined were anterior or posterior, if the teeth were endodontically treated previously, whether there was presence of endodontic lesion, if symptoms were present at the time of CBCT examination, if there was change in the diagnosis and treatment planning after CBCT examination and what type of treatment was carried out for each tooth after CBCT examination.

All the CBCT examination was carried out with the help of same CBCT machine (KAVO OP 3D Pro CBCT). The specifications for conducting all the CBCT examination was kept constant. The exposure parameters were adjusted as per the instructions of manufacturers. The magnitude of voltage required was adjusted to be 90 kVp. The magnitude of current supply was automatically regulated by CBCT machine itself which was adjusted between 3Ma and 7mA depending upon the subjects physical parameters. The exposure time of the CBCT was adjusted at 9 sec while the total time for examination was 17 sec

The data were recorded in excel and statistical analysis was carried out with the help of Pearson Chi square test and fisher's exact test. The level of significance

was adjusted at $p \leq 0.05$. All the statistical analysis was carried out using STATA version 15.1 version (USA).

Results

In this study a total of 437 endodontic cases (215 new cases and 222 retreated cases) were selected out of which it was found that 134 patients (30.66%) were referred for CBCT examination. In these CBCT examinations a total of 158 teeth were examined and radiographic interpretation was carried out for these teeth. It was the main study sample with 158 teeth and 134 patients. Planning for surgical treatment was the most common reason for referral for CBCT in 58 patients in which 68 teeth were examined. (Figure 1 to 4). The diagnosis of the resorption of teeth (internal as well as external resorption) due to inflammatory process was the second most common reason for referral to CBCT when 22 patients were referred for this reason in which 28 teeth were examined. Planning for the non surgical management of endodontic lesion was the reason for referral in 18 patients with 25 teeth. Evaluation of complications due to procedural errors as part of diagnostic process in endodontics was the reason for referral in 12 patients with 12 teeth. Identification of vertical fractures of root as part of diagnostic process in endodontics was the purpose for referral in 12 patients with 12 teeth. Assessment of anatomy of teeth preoperatively was reason for referral in 12 patients with 13 teeth. (Table1).

It was observed that 60.75% of teeth being examined were anterior teeth while 39.25% were posterior teeth. Endodontic therapy has been already performed in 62.65% cases. Presence of endodontic lesion was present in 120 cases (75.94%). Symptoms were already present in 70.88% cases. In 102 cases (64.55%) there was no major change in diagnosis after the CBCT examination while in 56 cases (34.45%) diagnosis was changed after CBCT examination. However in most of cases (62.02%) there was major change in the treatment planning after CBCT examination. The finding was statistically significant with ($p = 0.01$) (Table 2). After interpretation of CBCT, surgical treatment was carried out in 79 teeth while conventional treatment was performed in 39 teeth. Conventional treatment alongwith surgical treatment was carried out in 05 teeth. Extraction was treatment option in 21 teeth. No treatment was carried out in 14 teeth after CBCT examination. (Table 3)

Discussion

This study was carried out to evaluate the main reasons for the referral of endodontic patients for CBCT examination and the impact of preoperative CBCT examination in diagnosis and treatment planning of these patients. In present study it was found that 30.66 % endodontic patients were referred for the CBCT examination. Mota de Almeida et al also conducted a study to find out the use of CBCT among endodontic patients but the percentage of endodontic patients who were referred for CBCT was lower as compared with this present study.^{1,13,17} Kakavetsos VD et al also conducted a study to evaluate the use of CBCT in endodontic subjects at private dental clinic and the percentage of endodontic patients referred for CBCT was lower as compared with the present study. Although there can be several reasons for low percentage in these studies but the

decreased accessibility of CBCT machine at private clinics can be an important factor for reduced percentage of referrals. This was supported by the fact that in previous other two studies the percentage of referral was greater in private clinics where the CBCT machine was installed.¹⁴

In our study, treatment planning for endodontic surgery was the most common reason for referral of endodontic patients for CBCT examination. The results were similar to several studies conducted to evaluate the use of CBCT in endodontic subjects. Mota de Almeida et al conducted a similar study and results were similar as reported in the present study.^{1,17} In another study conducted by Setzer et al which was a questionnaire-based study it was found that CBCT was very effective in designing the proper treatment planning for endodontic surgeries and the most common reason for referral to CBCT examination was planning endodontic surgery.^{13,15} CBCT provided three dimensional information about the endodontic lesions which help in treatment planning. Besides it gave accurate information about the dimensions of lesion in all three planes. It also gave information about the proximity of lesion with the adjacent important anatomical structures like nasal floor, mandibular canal and sinus floor. All these factors helped in proper planning of surgery which was helpful for clinician as well as patients. CBCT also helped in identifying the exact location of lateral lesions which were quite difficult to locate conventionally. CBCT examination helped in making the surgery less invasive.¹⁶

In this study the second most common reason for referral of endodontic patients for CBCT examination was evaluation of internal and external root resorption. The results were similar to the studies conducted by the Rodríguez G et al and Mota de Almeida et al.^{1,10,17} The cases which were referred for CBCT were treated properly after CBCT examination as there was exact information about the extent and location of these abnormalities. CBCT helped in obtaining the exact radiographic details of the internal and external resorption which were not obtained from the two dimensional imaging. In previous studies also it has been found that CBCT is very effective in proper diagnosis and treatment planning in internal and external resorption.¹⁸ CBCT was also helpful in analysing the prognosis of the treatment. There were some teeth which were extracted after CBCT examination because the extent of resorption was much more as assessed before the CBCT. These teeth were planned for endodontic treatment before CBCT examination because the two dimensional imaging techniques were unable to provide exact and location of the defects. Kalendar A et al found that CBCT was very effective in diagnosis and treatment planning of internal resorption.²⁴

In this study all the cases which were diagnosed with probable vertical fracture were referred for CBCT examination. However the number of such cases were as low as 12 only. All these cases were endodontically treated but the patients complained of pain. In these cases proper assessment was carried out and the extent of vertical fracture was confirmed with the help of CBCT examination. After proper assessment prognosis of the endodontic treated tooth was evaluated and decision for extraction of some teeth was taken because the CBCT examination revealed that extent of vertical fracture was much more as assessed before the CBCT examination. Similar findings has been observed in study conducted by Krug R et al and Al-Salehi SK who also found CBCT to be helpful in proper

treatment planning and diagnosis of vertical fracture.^{15,18} Generally vertical fractures are more commonly observed in teeth with post and core. These vertical fractures get undiagnosed.²¹ So it should be taken care that proper history and clinical examination should be taken in patients with post and core. If such patients report some symptoms then CBCT examination should be carried out. Coronal view in CBCT imaging give the information about vertical fracture. This vertical fracture is very difficult to diagnose with the conventional two dimensional imaging.²²

When impact of CBCT was analysed over the diagnosis and treatment planning in our study then there was change in diagnosis in 34.45 % cases while treatment planning was changed in majority of cases (62.02%). The findings of this study are similar to the study conducted by Almeida MD et al and Al-Salehi SK et al in which it was observed that there was not major change in the diagnosis in majority of cases although the radiographic details obtained were helpful in change in treatment planning of the endodontic cases.^{1,17,18} CBCT has many advantages but two of its major disadvantages are high radiation exposure and high cost. The limitation of this study was that number of referred cases had been limited due to high cost and high radiation exposure risk from CBCT. More studies with large sample size should be carried out in future.

Conclusion

Findings of the present study were

1. Treatment planning for surgery was the most common reason for referral of endodontic patients to CBCT examination
2. There was change in treatment planning in majority of the endodontic subjects referred for CBCT imaging
3. There was major change in diagnosis in less than half of the endodontic subjects referred for CBCT imaging while confirmation of preliminary diagnosis was also observed in most of the cases.

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Table 1. Reasons of referral to CBCT imaging alongwith number of patients and number of teeth

	Reasons of referral to CBCT imaging	No of patients	No of teeth
1.	Planning for surgical treatment	58	68
2.	Planning for non surgical management as part of diagnostic process in endodontics	18	25
3.	Evaluation of complications due to procedural errors as part of diagnostic process in endodontics	12	12
4.	Identification of vertical fractures of root as part of diagnostic process in endodontics	12	12
5.	Diagnosis of the internal and external resorption due to inflammatory process	22	28
6.	Assessment of anatomy of teeth preoperatively	12	13
	Total	134	158

Table 2: Analysis of the impact of preoperative CBCT in endodontic cases

	Referral Reasons				Total		p value
	Reasons concerned with Endodontic Diagnosis		Reasons concerned with Endodontic Surgery				
	N	%	N	%	N	%	
1. Type of tooth							0.04
a)Anterior tooth	54	60.00	42	61.76	96	60.75	
b)Posterior tooth	36	40.00	26	38.24	62	39.25	

2. Endodontic Therapy							
a) Present	56	62.22	43	63.23	99	62.65	0.03*
b) Absent	34	37.78	25	36.77	59	37.35	
3. Presence of lesion							
a) Present	68	75.55	52	76.47	120	75.94	0.04*
b) Absent	22	24.45	16	23.53	38	24.06	
4. Symptoms present							
a) Present	64	71.11	48	70.58	112	70.88	0.02*
b) Absent	26	28.89	20	29.42	46	29.12	
5. Change in Diagnosis							
a) Observed	31	34.5	25	36.77	56	35.44	0.53
b) Not observed	59	65.5	43	63.23	102	64.55	
6. Change in treatment planning							
a) Observed	56	62.22	42	61.76	98	62.02	0.01*
b) Not observed	34	37.78	26	38.24	60	37.98	
Total	90	100	68	100	158	100	

*: Statistically significant

Table 3: Clinical treatment after interpretation of CBCT

S.No	Treatment procedures after interpretation of CBCT	No of teeth
1.	Surgical treatment	79
2.	Conventional treatment	39
3.	Surgical and conventional treatment	05
4.	Tooth Extraction	21
5.	None of the above	14
	Total	158

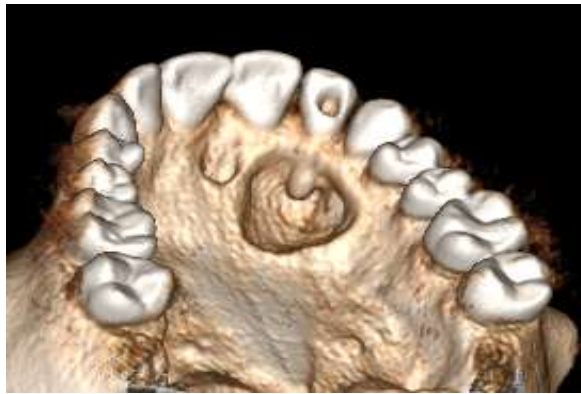


Fig 1 : CBCT 3D image showing endodontic lesion in maxillary anterior region

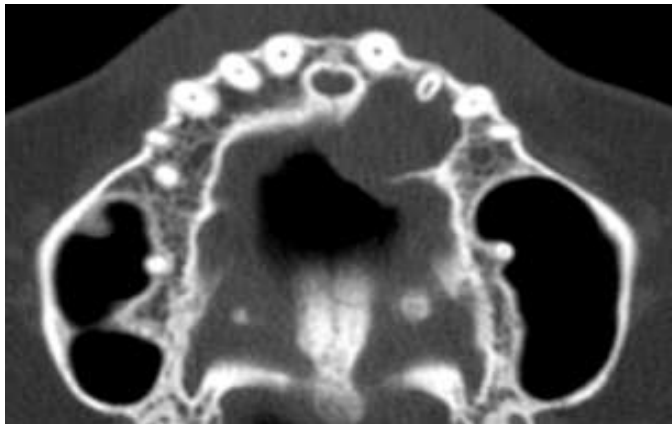


Fig 2 :CBCT Axial section showing buccolinual extent of endodontic lesion

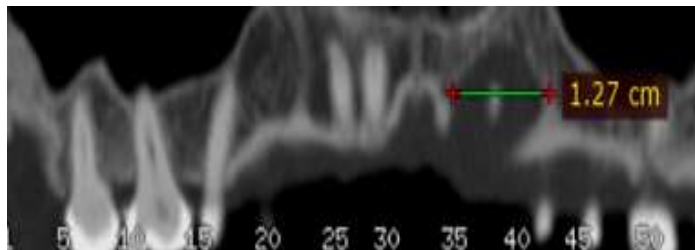


FIG 3:CBCT image showing mesiodistal width of the lesion

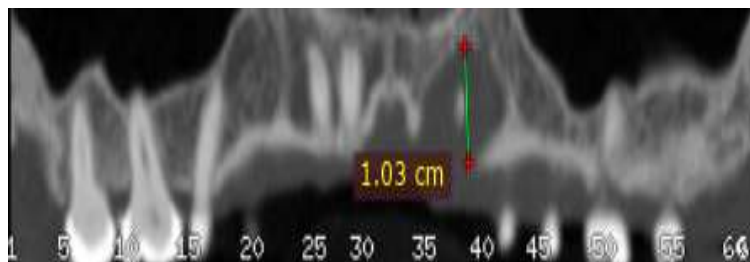


FIG 4: CBCT image showing cervico-occlusal width of lesion