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Pattern of CBCT Reference in Various Dental Specialities

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Abstract

Aims and Objectives: To conduct a survey on current referral pattern of CBCT imaging among various dental specialties in a government dental institution in Mumbai, Maharashtra.

Method: A total of 2106 referral forms of CBCT scans taken between 2012 -2017 were analyzed retrospectively on parameters of patient gender, age, specific site, purpose of scan and annual variation. The data thus collected was analyzed using SPSS version 19.0

Results: Maximum referrals were from the department of oral and maxillofacial radiologists at 39.8%, a total of 58.7% of the total scans were requested for treatment planning purposes with implant planning being the most cited reason at 52.1%.

Conclusion: Our study shows that there is a rising trend in use of CBCT with the progress of years among the dental practitioners. Though implant planning is the prime reason for CBCT imaging in dentistry, it is increasingly being used for various other diagnostic and treatment planning purposes as well. There exists a growing demand and need for educating the dental specialists in the various uses of CBCT and importance of providing apt data to the radiologists to facilitate optimum imaging of the patient.

Keywords: CBCT, Implant, Dental Speciality.

Introduction

The discovery of X-rays by Wilhelm Conrad Roentgen on November 8, 1885 ^[1] and its subsequent induction in the dental field by Otto Walkhoff ^[1] came as a huge advantage for the clinicians who had to till then rely on clinical examination alone for diagnosis and treatment planning of their patients. It enabled the clinicians for the first time to look inside their patient's body non-invasively and greatly facilitated the understanding of the disease process. The first attempt at 3D reconstruction of the body was with the introduction of CT-scan in the year 1967 by G.N. Hounsfield ^[2] and it heralded a new era in medical imaging. The first Cone Beam CT scanner was built by Robles RA in 1982 for angiography purpose ^[3] and it became commercially available for dentomaxillofacial imaging in 2001 (New Tom QR DVT 9000; Quantitative radiology Verona Italy) ^[4] Though it has gained widespread acceptance in the dental fraternity within just a few years of its induction, being a relatively newer technology, it's far from achieving its full potential in terms of its various uses, and with each passing day newer and more advanced applications of CBCT are being discovered not only in the dental field but in various other non-dental fields as well.

CBCT is a vast improvement on the conventional radiographs and has been considered as the examination of choice in many instances. It provides high resolution imaging with 3-dimensional data of the region of interest, diagnostic reliability and risk benefit assessment ^[5-6], nevertheless, it is far from replacing traditional dental imaging for a number of reasons, including higher machine costs and maintenance costs, prolonged exposure time, higher radiation dosage, increased time to manipulate and interpret images, and decreased diagnostic ability in certain instances (dental metal artifacts) and limited inner soft tissue information ^[7]. Though the radiation dose to the patient with CBCT is 40% lower than that of multi-slice CT, it is 3-7 times more than conventional panoramic radiograph exposure dose. Also, one needs to take into consideration that, a more sensitive technology may result in over diagnosis and overtreatment (Moynihan *et al.* 2012) ^[8] As a profession we are under obligation to place patient safety above our own self interest by ensuring safe and efficacious use of ionizing radiation in dental practice ^[9].

The basic principal of using CBCT is that it should be reserved for cases where conventional radiography is unable to provide the information required for diagnosis of treatment [10]. The first radiographic guidelines on selection criteria for asymptomatic teeth were published by the United States Food and Drug Administration (FDA) in 1987 [1]. In 2012, the updated AD Aguidelines explicitly excluded CBCT, citing that the indications for the same are not well-developed [1].

While case reports regarding utilization of CBCT exist, there is insufficiency in the literature regarding the referral patterns for CBCT. This article provides an insight into the trends in the pattern of CBCT referrals by practitioners of different dental specialties in a hospital setting in Mumbai. The article also highlights the indications for which CBCT examinations are being sought, as well as focuses on the patient profiles and demographics (by age and gender) referred for CBCT. This will help us in determining the prevalent and most common domain of CBCT application in the region and also, furnish information regarding the segment of patients seeking or willing to undergo CBCT examinations. Through this study we aim to assess the clinician’s awareness regarding the various applications and risk-benefit profile of CBCT and their current usage pattern, and also, establish the need to educate them regarding the same. This study also aims to establish the need for completely filled CBCT referral forms which will help the Oral radiologists to better cater to the needs of the referring doctor. This information could vastly help the health care providers in shaping future imaging guidelines and in identification of specialties most utilizing CBCT and the ones where there is suboptimal use of the same. It will also help in identification of the various indications for which CBCT is being most sought out and enhance interdepartmental co-operation for providing holistic care to the patient.

Material and Methods

The present study was carried out in the department of Oral Medicine and Radiology, Government dental college and hospital, Mumbai, to evaluate the referral criteria of various departments requesting CBCT scans. A total of 2106 CBCT referral forms for scans taken between 2012 – 2017 at Government Dental College and Hospital, Mumbai, were analyzed retrospectively. Patients referred from within the hospital as well as those referred from external institutions were considered. As it was a retrospective study, the patients consent was not sought and to maintain their privacy the names as well as their case numbers were not included. Ethical committee clearance was gained for the study prior to proceeding with it. The forms where one or more than one major information columns were found to be missing were considered as incomplete and were not

included in the statistical analysis though they were included as a part of the study. The data fields to be collected were identified prior to reviewing the requisition forms. For patient’s demographics, the gender and age, on the day the CBCT was acquired. Clinical findings and other radiographs as provided in the requisition form were considered as well. The scans were segregated according to their purpose into 2 major categories as diagnostic and treatment planning. These categories were further subdivided into various subcategories as follows: –



Occasionally when a single scan could satisfy a multiple selection criteria, the first indication listed was considered the primary reason for the scan. Data collected was entered into Microsoft excel (version 2007), and thereafter subjected to statistical analysis (SPSS version 19.0).

Result

A total of 2106 requisition forms were scanned, out of which 1828 (86.8%) forms were complete in all respects and included in the study analysis, while 278 (13.2%) scans, which were incomplete, were not considered.

The mean age of patients referred for CBCT in our study was 34±15 years (fig 1) (table1). Out of the total scans considered 1072 were males (58.6 %) and 756 were females (41.4%) (Fig 2)(Table 2). Also the maximum representation was from the age group of 19-40 yrs at 990 (54.15%) and they comprised of more than half of the total number of patients. The age group least represented in the survey were from 4-18 yrs at 263 (14.44%) (fig1) (Table 1).

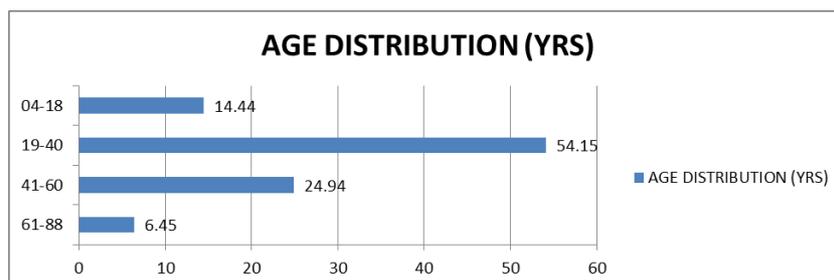


Fig1: Percentage distribution of CBCT scans according to age

Table 1: Percentage and number representation of CBCT scans according to age)

Age Groups	Mean Age	Number Representation	Percentage Representation
04-18	14.04	263	14.44
19-40	28.18	990	54.15
41-60	49.84	457	24.94
61-88	66.33	118	6.45

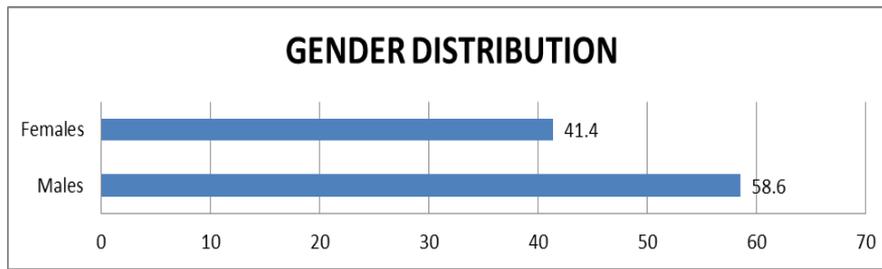


Fig 2: Percentage distribution of CBCT scans according to gender)

Table 2: Number and Percentage distribution of CBCT scans according to gender)

Gender	Male	Female
Number Representation	1072	756
Percentage Representation	58.6	41.4

Maximum referrals were from oral and maxillofacial radiologists 727/1828 (39.8%), followed close behind by prosthodontists 452/1828 (24.7%), followed by oral and

maxillofacial surgeons 359/1828 (19.6%). Representation from the department of conservative dentistry and endodontic and periodontal was a meager 131/1828 (7.2%) and 116/1828 (6.3%) respectively. Department of Pedodontia had the least representation, in the dental specialties at 6/1828 (0.3%). Also, of the total number of requisition forms for CBCT, only 2/1828 (0.1%) were demanded by general practitioners, and those referred by ENT specialist was just 1/1828 (fig 3) (Table 3).

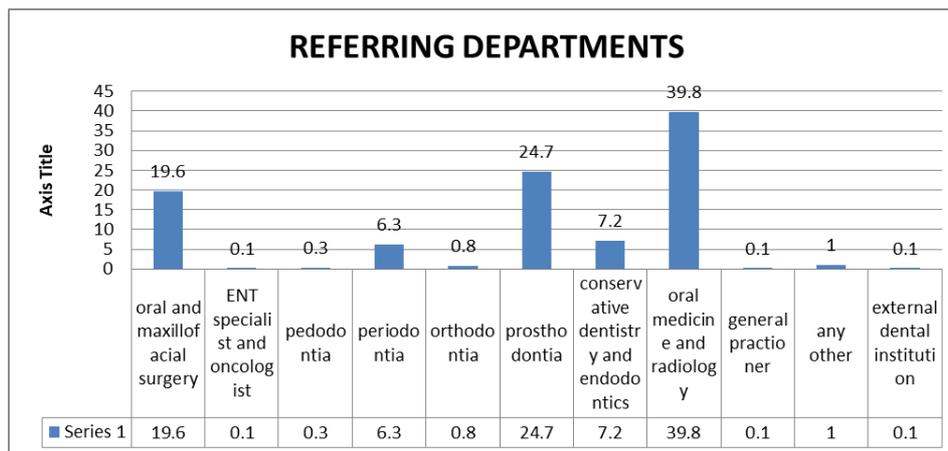


Fig 3: Percentage distribution of CBCT scans according to referring departments

Table 3: Number and Percentage distribution of CBCT scans according to referring departments)

Referring Department	Number Distribution	Percentage Distribution
Oral And Maxillofacial Surgery	359	19.6
Ent Specialist And Oncologist	1	0.1
Pedodontia	6	0.3
Periodontia	116	6.3
Orthodontia	15	0.8
Prosthodontia	452	24.7
Conservative Dentistry And Endodontics	131	7.2
Oral Medicine And Radiologist	727	39.8
General Practitioner	2	0.1
Any Other	18	1
External Dental Institution	1	0.1

Total number of scans requested for treatment planning purpose were 1073/1828 (58.7%) which was significantly more than diagnostic scans 755/1828 (41.3%) of the total (fig4) (Table 4). CBCT scans requested for diagnostic purpose were maximum for cases of facial swelling 187/755 (24.8%), followed by maxilla-mandibular pathology 77/755

(10.2%) and periodontitis 77/755 (9.4%). (fig 5) (table 5). Among treatment planning, maximum CBCT scans were demanded for the purpose of implant planning at 559/1073 (52.1%), teeth impaction 154/1073 (14.4%) came at far second (fig 8) (table 8).

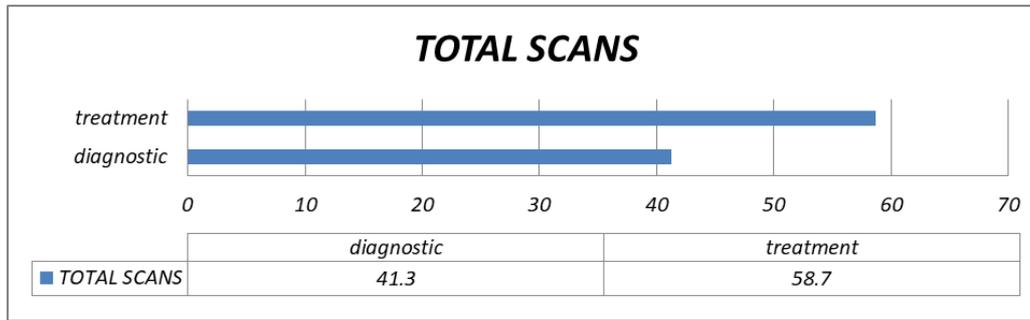


Fig 4: Percentage distribution of scans according to treatment and diagnostic purposes

Table 4: Number and percentage distribution of scans according to treatment and diagnostic purposes

Scan Criteria	Number Representation	Percentage Representation
Diagnostic	755	41.3
Treatment Planning	1073	58.7

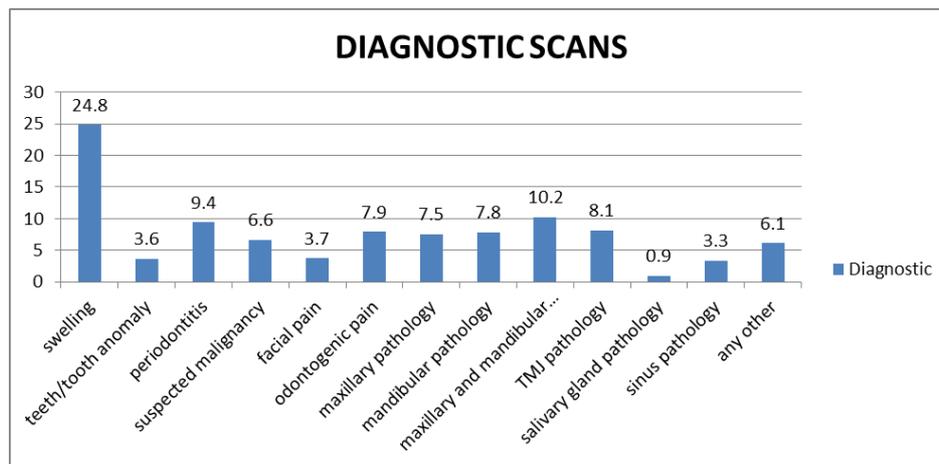


Fig 5: Percentage distribution of diagnostic scans according to causes

Table 5: Number and percentage distribution of diagnostic scans according to causes

Concerned Diagnosis	Number Representation	Percentage Representation
Swelling	187	24.8
Teeth/Tooth Anomaly	27	3.6
Periodontitis	71	9.4
Suspected Malignancy	50	6.6
Facial Pain	28	3.7
Odontogenic Pain	60	7.9
Maxillary Pathology	57	7.5
Mandibular Pathology	59	7.8
Maxillary And Mandibular Pathology	77	10.2
Tmj Pathology	61	8.1
Salivary Gland Pathology	7	0.9
Sinus Pathology	25	3.3
Other	46	6.1

About 18.3% of the total cases for diagnostic purposes, referred for CBCT from the department of Oral Medicine and Radiology were for swelling, this was also, the prime cause for referral from the departments of Oral and Maxillofacial surgery (10.6%), Pedodontia (16.7%) and conservative dentistry and endodontic (6.1%) (fig6) (table6). Maximum cases of diagnostic scans, reported for swelling were in the age group of 61-88 years at 15.3% followed by 04-18 years at 12.1 % (fig7). Though among maxillary and mandibular pathology maximum scans requested were for the age group of 04-18 years at 14 % (fig7). Among both the genders, swelling was the most common cause for seeking diagnostic scanning at 10.8% for females and 9.8% for

males followed by maxillary and mandibular pathology at 4.2% each (fig7).

Impaction was the major reason for seeking CBCT scans from the department of Oral and Maxillofacial surgery (31.5%) and Orthodontia (40%) whereas, implant planning was almost the solereason for CBCT scans in the department of Prosthodontia (90.9%), it also, represented around half of the treatment planning scans in Periodontal (16.7%) (fig9) (table9). Among scans requested for planning of treatment for the patients, implants were sought most by the patients belonging to the age group of 61-88 years at 44.9% followed closely by the age group of 41-60 years at 43.6% (fig 10). Cases of impaction were reported largely by

patients falling in the age bracket of 19-40 years at 11% followed by those in the age group of 04-18 years (fig 10). Cases with maxillofacial trauma were also seen to be maximum in the age category of 04-18 years with male predominance at 7.7%. 32.1% of the total females reporting for CBCT scans were interested in dental implants where as

only 29.5% of the males wanted to undergo implant surgery. Endodontic complications were seen mostly in the age group of 19-40 years. Whereas scans for developmental anomalies were requested mostly for age group of 04-18 years as can be expected at 3.8% (fig 10).

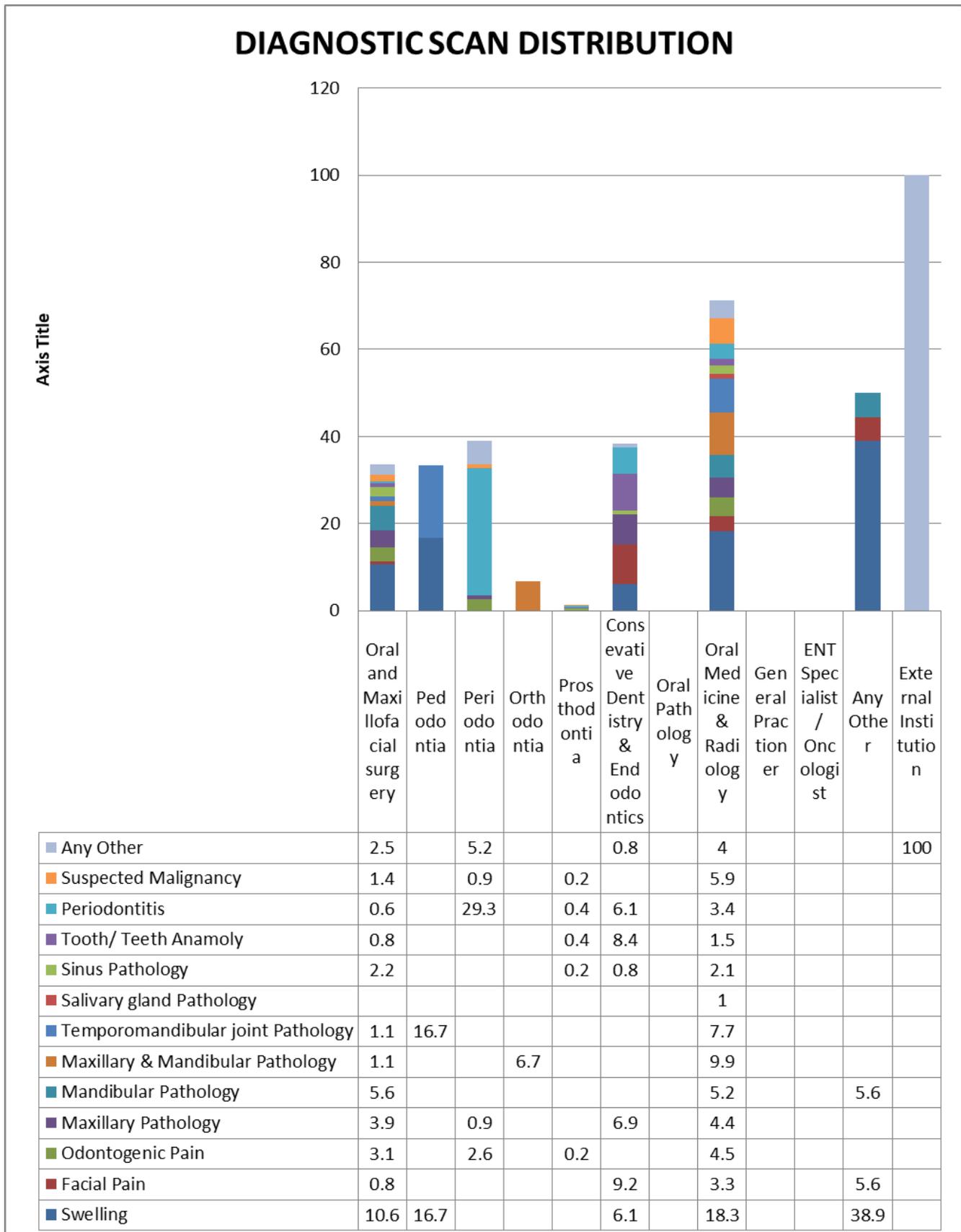
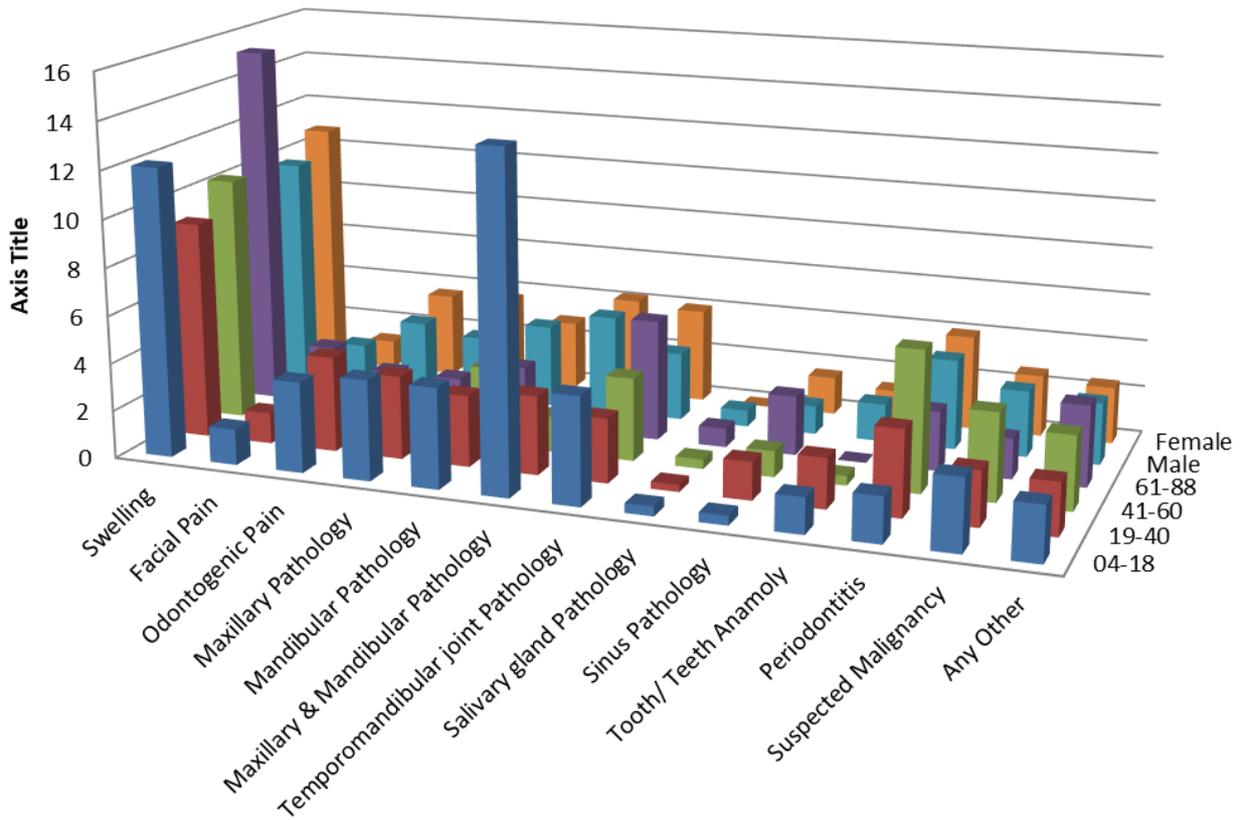


Fig 6: Diagnostic scan distribution according to referring department and causes)

Table 6: Distribution of CBCT diagnostic scans according to department and causes

	Swelling	Facial Pain	Odontogenic Pain	Maxillary Pathology	Mandibular Pathology	Maxillary & Mandibular Pathology	Temporomandibular Joint Pathology	Salivary Gland Pathology	Sinus Pathology	Tooth/Teeth Anamoly	Periodontitis	Suspected Malignancy	Any Other
Oral And Maxillofacial Surgery	10.6	0.8	3.1	3.9	5.6	1.1	1.1		2.2	0.8	0.6	1.4	2.5
Pedodontia	16.7						16.7						
Periodontia			2.6	0.9							29.3	0.9	5.2
Orthodontia						6.7							
Prosthodontia			0.2						0.2	0.4	0.4	0.2	
Consevative Dentistry & Endodontics	6.1	9.2		6.9					0.8	8.4	6.1		0.8
Oral Pathology													
Oral Medicine & Radiology	18.3	3.3	4.5	4.4	5.2	9.9	7.7	1	2.1	1.5	3.4	5.9	4
General Practioner													
Ent Specialist/ Oncologist													
Any Other	38.9	5.6			5.6								
External Institution													100

Diagnostic Scans Accordin to Age and Gender



	Swelling	Facial Pain	Odontogenic Pain	Maxillary Pathology	Mandibular Pathology	Maxillary & Mandibular Pathology	Temporomandibular joint Pathology	Salivary gland Pathology	Sinus Pathology	Tooth/Teeth Anamoly	Periodontitis	Suspected Malignancy	Any Other
■ 04-18	12.1	1.5	3.8	4.2	4.2	14	4.5	0.4	0.4	1.5	1.9	3	2.3
■ 19-40	9.1	1.3	4	3.5	3	3.3	2.7	0.3	1.6	2.1	3.6	2.3	2.2
■ 41-60	10.3	1.8	1.8	2	3.3	1.5	3.5	0.4	1.1	0.4	5.9	3.7	3.1
■ 61-88	15.3	2.5	1.7	1.7	2.5	0	5.1	0.8	2.5	0	2.5	1.7	3.4
■ Male	9.8	1.8	3.1	2.7	3.5	4.2	2.9	0.7	1.2	1.6	3.8	2.8	2.6
■ Female	10.8	1.2	3.6	3.7	2.9	4.2	4	0	1.6	1.3	4	2.6	2.4

Fig 7: Diagnostic scan distribution according to gender, age profile and reasons

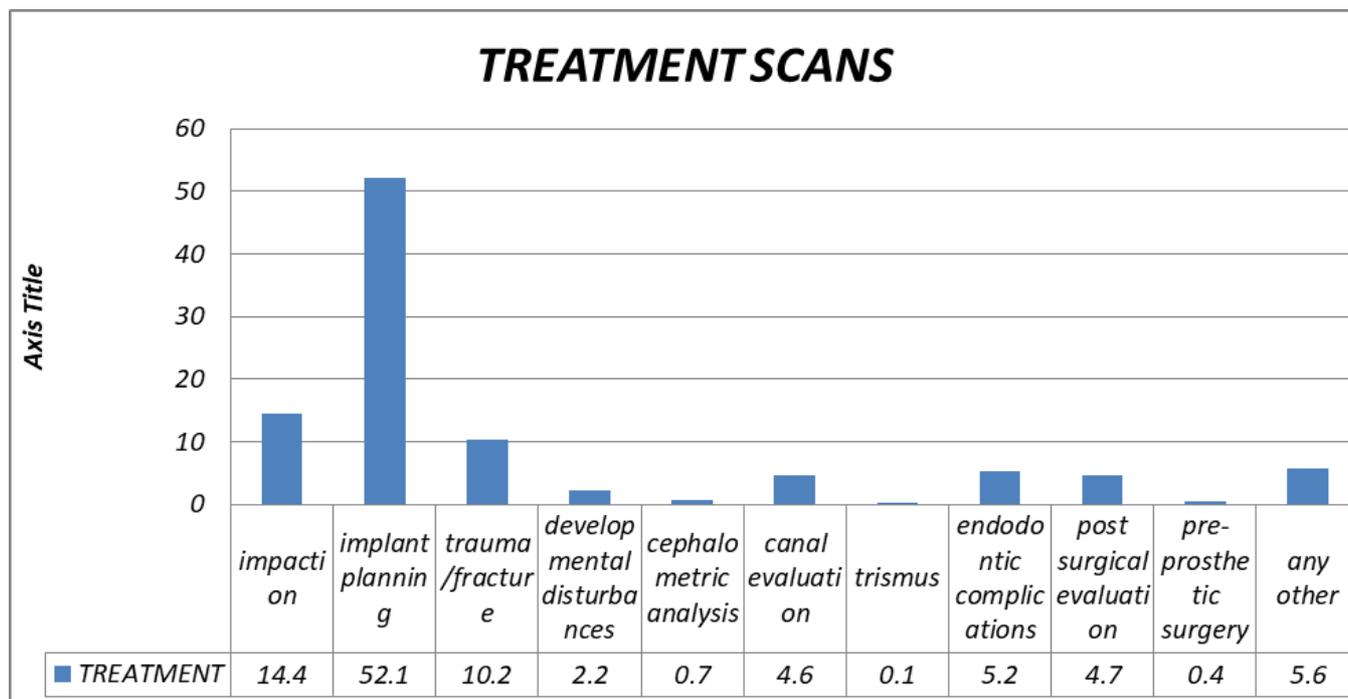


Fig 8: Percentage distribution of treatment scans according to causes

Table 8: Number and percentage distribution of scans according to causes)

Treatment Planned	Number Representation	Percent Representation
Impaction	154	14.4
Implant Planning	559	52.1
Trauma/Fracture	109	10.2
Developmental Disturbances	24	2.2
Cephalometric Analysis	7	0.7
Canal Evaluation	49	4.6
Trismus	1	0.1
Endodontic Complications	56	5.2
Post Surgical Evaluation	50	4.7
Pre-Prosthetic Surgery	4	0.4
Any Other	60	5.6

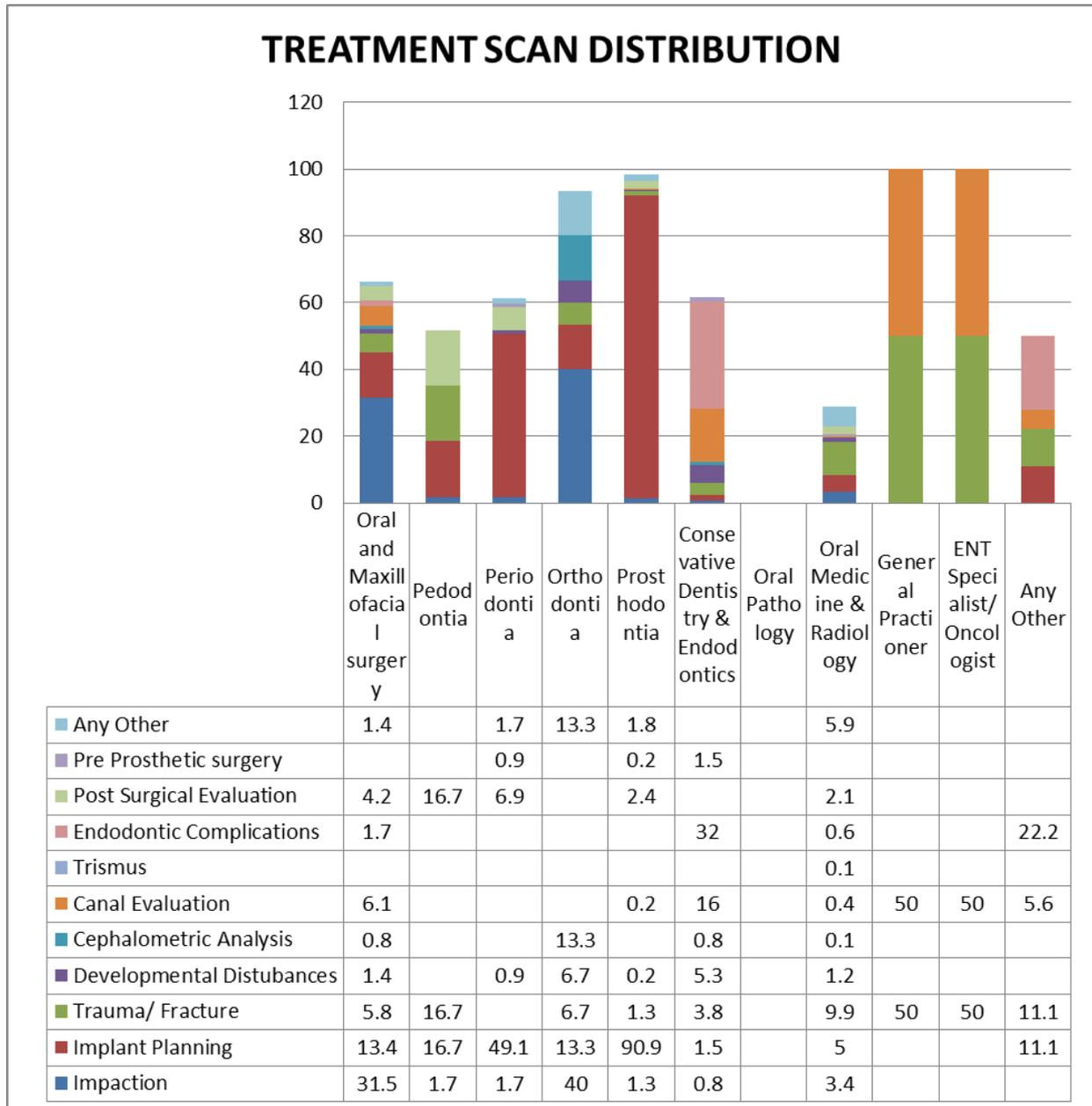
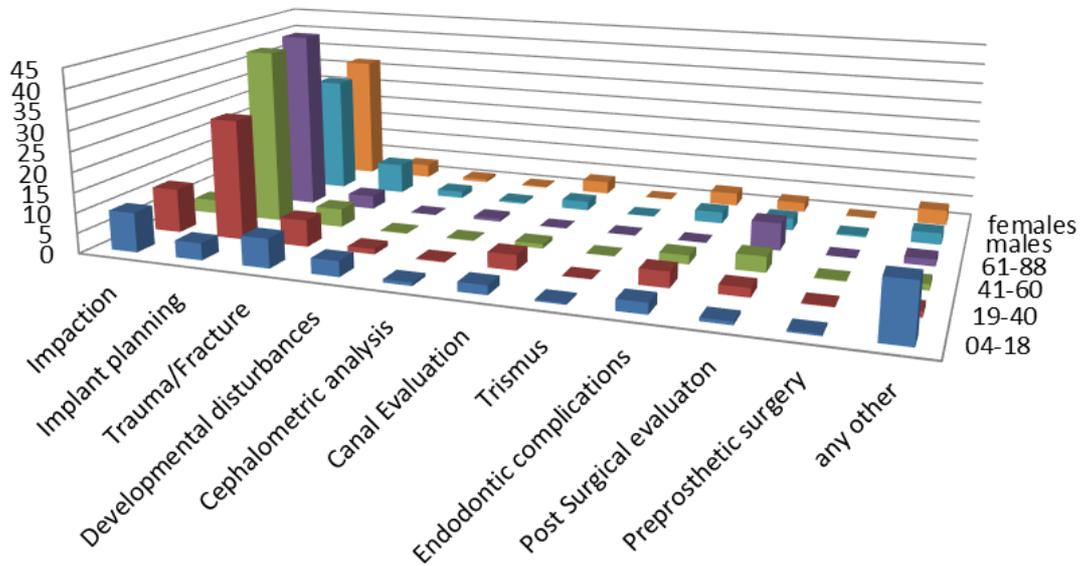


Fig 9: Distribution of treatment scans according to department and reasons

Table 9: Distribution of treatment scans according to department and reason

	Impaction	Implant Planning	Trauma/ Fracture	Developmental Disturbances	Cephalometric Analysis	Canal Evaluation	Trismus	Endodontic Complications	Post Surgical Evaluation	Pre Prosthetic Surgery	Any Other
Oral And Maxillofacial Surgery	31.5	13.4	5.8	1.4	0.8	6.1		1.7	4.2		1.4
Pedodontia	1.7	16.7	16.7						16.7		
Periodontia	1.7	49.1		0.9					6.9	0.9	1.7
Orthodontia	40	13.3	6.7	6.7	13.3						13.3
Prosthodontia	1.3	90.9	1.3	0.2		0.2			2.4	0.2	1.8
Conservative Dentistry & Endodontics	0.8	1.5	3.8	5.3	0.8	16		32		1.5	
Oral Pathology											
Oral Medicine & Radiology	3.4	5	9.9	1.2	0.1	0.4	0.1	0.6	2.1		5.9
General Practitioner			50			50					
Ent Specialist/ Oncologist			50			50					
Any Other		11.1	11.1			5.6		22.2			

Age and Gender distribution Pattern in Treatment Planning Scans



	Impactio n	Implant planning	Trauma/ Fracture	Develop mental disturba nces	Cephalo metric analysis	Canal Evaluati on	Trismus	Endodon tic complica tions	Post Surgical evaluato n	Preprost hetic surgery	any other
■ 04-18	9.8	4.2	7.2	3.8	0.8	2.3	0.4	2.7	0.8	0.4	14
■ 19-40	11	29.9	6.6	1.3	0.3	3.8	0	3.9	2.2	0.2	1.4
■ 41-60	3.5	43.6	4.6	0.2	0.2	1.1	0	2.2	3.9	0.2	1.5
■ 61-88	2.5	44.9	3.4	0	0.8	0	0	0	6.8	0	1.7
■ males	8.5	29.5	7.7	1.7	0.5	2.3	0.1	2.9	3	0.4	2.9
■ females	8.3	32.1	3.4	0.8	0.3	3.2	0	3.3	2.4	0	3.8

Fig 10: Treatment scans distribution according to gender and reasons

Though clinical data/provisional diagnosis was given in 50.4% of the cases, special instructions to aid in CBCT scans were provided only for 14.1% of the forms and previous radiographic records were furnished in only 24.9% of the cases.

Mandible (25.8%) and maxilla (24.5%) individually had almost equal representation in the regions scanned (FOV

16×50) followed by maxilla and mandible combined (FOV 16×90) at 21.4%, Full-face scans accounted for 13.1%, whereas third molars and specific tooth or quadrant made up around 2.4% and 12.8% of the total scans requested, respectively.(fig 11)(table 11).

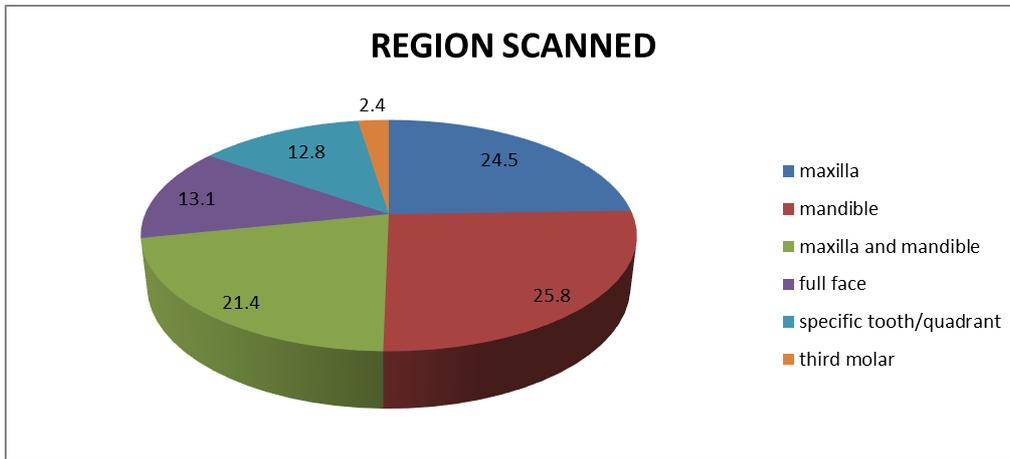


Fig 11: CBCT scan distribution according to region scanned)

Table 11: CBCT scan distribution according to region scanned)

Region Scanned	Number Distribution	Percentage Distribution
Maxilla	448	24.5
Mandible	472	25.8
Maxilla And Mandible	391	21.4
Full Face	240	13.1
Specific Tooth Or Quadrant	234	12.8
Third Molar	43	2.4

Annual distribution pattern shows that maximum number of scans were taken in the year 2015 (31.2%), followed by in the year 2016 (20.8%) and 2017(19.1%), this has shown a pattern of more or less steady increase from 2012 (6.2%),

which could be due to increased awareness about its applications among the various dental specialties in the hospital (fig 12) (table 12).

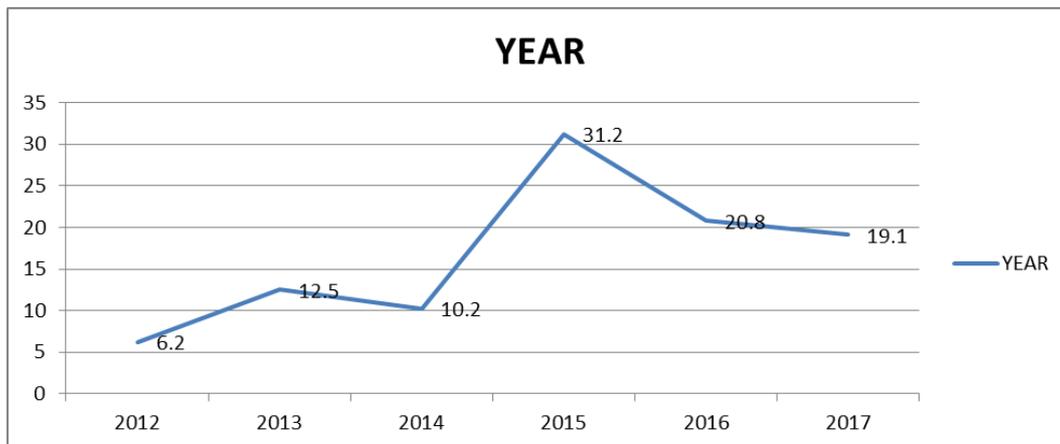


Fig 12: Frequency of CBCT scans according to year

Table 12: Number and percentage frequency of CBCT scans according to year)

Year	Number Distribution	Percentage Distribution
2012	113	6.2
2013	228	12.5
2014	187	10.2
2015	570	31.2
2016	381	20.8
2017	349	19.1

Discussion

The basic principal of using CBCT is that it should be reserved for cases where conventional radiography is unable to provide the information required for diagnosis or treatment [10]. In a study done in Manchester, UK by M, Dave *et al.* of all the radio graphical referrals, in (3.7%) of the cases the request for CBCT examination was judged to

be unnecessary [11]. Dental practitioners should prescribe CBCT imaging only when they expect that diagnostic yield will benefit patient care, enhance patient safety or improve clinical outcomes significantly [12]. Out of total 2106 requisition forms, about 13.2% were incompletely filled, which is quite a large number and portrays the lack of awareness among the referring dentists

regarding the importance of clearly stating the purpose of scan and providing complete information, in the optimum execution and reporting of CBCT scans of the referred cases. Prior radiographs were also provided in only 456 cases which is a meager 24.9%. Also, additional data was not provided in glaring 49.6% of the cases.

The mean age of patients referred for CBCT in our study was 34 ± 15 years with predominance of males (58.6%). In the study done by Warhekar *et al.*, the mean age of patients referred for CBCT was 37.20 ± 16.09 years with a predominance of males (56.7%). This data closely corresponds with that of our study^[5]. Although in the study done by Arnheiter *et al.*^[4], the mean age of patients referred for scan was 45 ± 21 years with a predominance of females (62%), the reason could be attributed to higher percentage of women in United States opting for dental implants and higher prevalence of TMJ pathoses among them.

In the study by Warhekar *et al.*^[5], maximum referrals were from oral and maxillofacial surgeons (21.9%), followed by oral radiologists (14.2%), whereas, in our study maximum referrals were from oral and maxillofacial radiologists (39.8%) followed by oral and maxillofacial surgeons (19.6%). The higher percentage of CBCT scans by oral radiologists in our study may also be due to their active involvement in CBCT use during their postgraduate training as a diagnostic and treatment planning aid leading to the increase in their knowledge and experience in the area.

In a study done by Garlapati Babu in 2017, he found that among dental practitioners who advised CBCT, General dentists comprised about 25%, followed by Oral and Maxillofacial Surgeons (23%) and prosthodontists (18.5%), Orthodontists (11.5%), endodontists (10%). Whereas the lowest representation were by periodontitis (6.5%), Oral radiologists (3.5%) and pedodontists (2%)^[13].

Currently, dental implant therapy is the major area of treatment requiring CBCT, with other areas such as impaction assessment, orthodontic evaluation, endodontic and Pedodontia adopting the same with increasing frequency. In our study as well implant planning (52.1%) was the primary reason for seeking CBCT scans. In the study done by Warhekar, implant planning accounted for 40% of the total scans taken. According to study done by Arnheiter in 2006, it was suggested that practitioners who have experienced the use of CBCT to guide implant placement do not return to prior methodologies^[4]. AAOMR recommends that although initial imaging assessment may be achieved with OPG supplemented with IOPAR, for preoperative diagnostic assessment a cross-sectional imaging be used for implant site assessment^[14]. According to the study done by Garlapati, 42% of the total referrals were for pre-implant assessment, whereas 19% were for post implant planning, impaction comprised about 15% of the total referrals, while root canal assessment (10%), orthodontic planning (5%), cysts (4%), jaw fractures (2%) comprised the rest, least number of referrals were for periodontal assessment at 2%^[13]. Though, according to a study done by Holc *et al.* periodontists and Oral Surgeons were the specialists who most frequently advised CBCT scans (Comparison and knowledge of perspectives towards CBCT) CBCT provides the clinician with more precise and accurate imaging, providing better preoperative information and thus helping avoid problems associated with surgery in sites close to vital structures or where compromising factors are present^[15].

About 7.8% of the cases from total were referred from the department of conservative dentistry and endodontics, out of these 4.6% of the cases were referred for canal evaluation while 5.2% of the cases were for endodontic complications such as fractured instruments, canal perforations, external/internal resorptions etc. This number is far less than the number of endodontic referrals (26%) in the study by Warhekar^[5]. CBCT has widespread use in endodontics, ranging from increasing use in CEA tooth preparation to determining endodontic lesions^[16]. CBCT has higher sensitivity and specificity when compared to conventional plane radiographs in the detection of root canal morphology and location including angulations, though at the expense of more radiation (Europium commission 2012, Peterson *et al.* 2012)^[8].

Least representation from the institution was from the departments of orthodontia (0.8%) and Pedodontia (0.3%). Among the surveyed Orthodontists, (56.3%) used CBCT during orthodontic diagnosis, the most frequently cited indications for CBCT was determination of impacted teeth and other oral abnormalities (80.9%), followed by cleft lip and palate (57.4%)^[17]. According to W.D Vos *et al.* in Belgium, among surveyed, (41%) Oral and Maxillofacial Surgeons preferred using CBCT for their case analysis followed by Orthodontists at (16%)^[18].

It is suggested that 3D visualization of the craniofacial complex can improve orthodontic treatment planning, airway analysis, evaluation of TMJ dysfunction, Orthognathic surgical planning and understanding of facial asymmetry^[17].

In the study done by Warhekar in Indore, the most frequently referred patient age groups were at 21-30 age group, and least in older age group. Whereas the CBCT scans were least recommended in the age groups of There are a number of areas where the use of CBCT was seen to be lacking in our institution, it was not routinely used for 3D template guided surgical planning, artificial intra-oral and extra-oral prosthetic rehabilitation of patients. The use in Orthodontic treatment planning was also seen to be limited to the assessment of impacted teeth

The sample size in our study was much greater (2106) as compared to the studies done by warhekar (795), and similar studies done by Price (300), Caglayan and Tozuglo (207 cases), cha *et al.*, (500 cases), Pete *et al.*, (318 cases)^[5].

According to a study done across middle eastern regions in 2018, it was seen that improved CBCT knowledge among dentists leads to increase in referrals where indications are justified and leads to better and many a times changed outcomes in diagnosis and treatment plans as compared with the use of traditional radiography^[19].

In A survey done in 2016 in K. M. Shah Dental College and Hospital, Sumandeep Vidyapeeth University, Vadodara, Gujarat, India. 74.84% of the participants comprising of dental students felt that education/training for CBCT should be provided during clinical phase of the study and made an integral part of the curriculum^[20].

Conclusion

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Conflicts of Interest

None.

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