

“Assessment of Response of Dental Clinicians and Patients towards Different Imaging Modalities Used In Diagnostic Evaluation of Dental Implant Therapy.”

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Abstract:

Aim: To assess the response of clinicians and patient towards various imaging modalities used in diagnostic evaluation of dental implant therapy.

Materials and Methods: 200 clinicians with more than 5 years of experience in implant dentistry were selected in study. Every clinician was requested to judge accessibility, maneuverability, accuracy, reproducibility, reliability, ease of understanding of target anatomy, ease of imaging documentation and ability to increase dental awareness through provided questionnaire, for each imaging modality. 70 patients seeking dental implant therapy were assigned into 7 different group- IOPA (n=10), OPG (n=10), Lat. Ceph (n=10), conventional CT (n=10) and Spiral CT (n=10), CBCT (n=10) and ICGI (n=10). Patients were advised to undergo radiographic imaging procedure specific to respective group.

Results: The clinicians in highly preferred the cross- sectional imaging over conventional radiographic imaging for diagnosis and treatment planning of implant. Among cross-sectional imaging, preference was greater for CBCT, ICGI and Spiral CT scan than conventional CT scan. Patient responded and tolerated the procedure very well for the cross sectional imaging than conventional radiographic imaging modalities. However, expense and accessibility were the only negative factor for cross-sectional imaging.

Conclusion: The clinician and patient response for cone beam Computed tomography either individually or associated with Interactive computer guided implantology, and Spiral CT scan were magnificent over conventional radiography for treatment planning of dental implant.

Key words: Cone-beam computed tomography CBCT; Interactive computer guided implantology (ICGI), Spiral CT, Dental implants; cross sectional imaging.

Introduction:

The long term success of dental implants depends on precise treatment and skillful surgical procedures. A limited bone volume and poor bone quality may predict inadequate integration of bone with implant and thus

early implant failure.

Preoperative radiographic assessment has recently gained important role in treatment planning for implant-supported prostheses. It often requires a more extensive radiographic examination than that used for other types of dental treatment. Several imaging modalities have been used for dental implant therapy includes periapical, panoramic, cephalometric radiography, Conventional computed tomography (CT), Spiral C T, Cone beam CT¹⁻⁵.

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Aim of present study was: 1) To assess accessibility, reliability, reproducibility and accuracy of different Imaging modalities by the clinical expertise. 2) To assess the response of clinician about ease of determining the final position of implant placement using different imaging modalities. 3) To assess patients response about different imaging modalities.

Material and Methods:

The study was a survey based on questionnaire format directed towards clinician, and also to patient who have undergone specifically advised imaging investigation.

The details of the number of clinician enrolled into private practice with more than 5 years of experience in implant dentistry were obtained from Mumbai Dental Association. Of these, 20% of clinicians were randomly selected, thus sample of 200 clinicians were selected from Mumbai, India. Every clinician had enormous knowledge about the conventional and recent imaging tools available for treatment planning of dental implant.

Imaging modalities included in the study were Periapical radiograph, Orthopantomograph (OPG), Lateral Cephalograph (Lat. Ceph), Conventional Computed Tomography (C.T.), Spiral Computed tomography (Spiral CT), Cone Beam Computed Tomography (CBCT) and Interactive Computer Guided Implantology (ICGI).

Data Collection:

The questionnaire format - I for Clinicians: It was related to above mention imaging techniques and was directed to judge accessibility, maneuverability, accuracy, reproducibility and reliability, ease of understanding of target anatomy, ease of imaging documentation, ability to increase dental awareness, and also, mentioning of any advantages of these techniques with their preference of choice.

The clinician judged accessibility, reliability, accuracy

and reproducibility in percentage (100% maximum). The ease of interpretation of anatomy of implant site was estimated from excellent to worst. The ability of imaging techniques to create awareness about implant therapy in patient was evaluated from best to worst.

The accessibility was judged by the quality of being easy to achieve and maneuverability was judged by ability to guide and visualize perfect treatment plan with the particular imaging. The reliability was assessed by quality of being trustworthy and by authenticity of imaging technique. The accuracy was estimated by quality of being near to the true value of any measurement made through these imaging modalities and reproducibility was evaluated by capability of imaging technique to produce the consistently similar image at any desired time. For each imaging modalities, clinicians were advised to judge accessibility, reliability, accuracy, reproducibility, ease of interpretation of target anatomy, ease of documentation of images and ability to increase dental awareness.

In order to evaluate the patient's response and feedback about imaging techniques, 70 patients from different clinics in Mumbai, willing to undergo implant therapy were selected. Patient were randomly assigned into 7 different group - IOPA (n=10), OPG (n=10), Lat. Ceph (n=10), conventional CT (n=10) and Spiral CT (n=10), CBCT (n=10) and ICGI (n=10). Patients were advised to undergo radiographic imaging procedure specific to respective group.

Following the imaging procedure, each patient was given a **Questionnaire format II**, which focused on response of the patient towards advised imaging modality.

The Questionnaire stressed on ease of imaging process, time of process, Imaging approach, understanding of treatment plan, Imaging documentation and expense of investigation.

The patients were instructed to judge ease, expense and time of process , approach of technique, level of understanding of treatment plan.

Table. No 1: Software used for different imaging modalities

Modality	Software
Spiral Computed tomography	SEINETSKY Dicom viewer
Cone beam Computed tomography	iCAT Vision
Interactive Computed Guided Implantogy	Expertease, Dentsply.

RESULTS:

Among 200 dentists, maximum clinicians preferred CBCT as their first preference of choice followed by spiral CT and ICGI. (Table No. 2.)

Table No 2: Shows Number of clinician with first preference of choice.

Sr no.	Modality	No. of clinician with first preference of choice
1	IOPA	11
2	OPG	3
3	Lat Ceph	-
4	C.T. Scan	13
5	Spiral C T scan	38
6	CBCT	119
7	ICGI	16
Total (n =)		200

After collecting data, quality of each technique (accessibility, maneuverability, accuracy, reproducibility and reliability) was assessed by calculating mean value of individual quality judged by each clinician (**Table no 3**). It showed accessibility was greatest for IOPA, accuracy, reproducibility and reliability was greatest for CBCT, Spiral CT scan, ICGI and maneuverability was highest for CBCT, ICGI, IOPA and Spiral CT.(Table no. 3.)

The number of clinicians (in %) graded understanding of local anatomy and ability to increase dental awareness for each modality. The maximum number of clinicians rated excellent for CBCT, Spiral CT and ICGI and poor for OPG, Lat Ceph and IOPA with respect to understanding of local anatomy and ability to increase dental awareness (**Table no 4**).

Many clinicians preferred documentation of images on CBCT, ICGI & spiral CT as easy and feasible through the software controlled program whereas documentation of IOPA, OPG, Lat Ceph, and conventional CT scan were found to be difficult as it required external picturisation which never provided details of image measurement (**Table no. 5**).

After reviewing patient response to advised imaging modality, IOPA and conventional CT were found to be most uncomfortable whereas CBCT, Spiral CT and ICGI were responded to be very comfortable for the patients. The patient also responded that CBCT, Spiral CT and ICGI comparatively took less time for completion of overall imaging process than other modalities but were judged to be very expensive than other imaging modalities (**Table no. 6**).

The understanding of needs of the treatment by the patient (level of understanding of treatment) were judged to be excellent with CBCT, ICGI, Spiral CT & conventional CT Scan and fair with IOPA & OPG, and poor with Lat Ceph (**Table no. 7**).

Many patients considered ICGI as a highly advanced technique and CBCT and spiral C.T as a moderately advanced technique whereas IOPA, OPG, Lat Ceph and conventional CT were judged to be traditional technique (**Table no 7**).

Table no 3: Mean values of quality assessed by different clinicians in percentages about different imaging modalities.

Sr no	Quality assessed	IOPA %	OPG %	Lat. Ceph %	C.T. Scan %	Spiral C.T. %	C.B.C.T %	I.C.G.I %
1	Accessibility	98.3	62	60.3	72	51.5	52	27.3
2	Maneuverability	87.8	49.3	41	48	82.3	86.6	87
3	Accuracy	74	28.9	18.3	64	93	97	98
4	Reproducibility	68	19	22	68	94	96	95.5
5	Reliability	59	23	21.3	75	90	92.5	91.3

Table no 4: Number of clinician in percentage (n= 200) who judged grade for each Imaging techniques with respect to understanding of local anatomy and ability to increase dental awareness through better understanding of treatment plan.

Sr no	Imaging technique	Understanding of local anatomy				Ability to increase dental awareness			
		Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor
1	IOPA	4%	24%	53%	19%	13%	15%	18%	54%
2	OPG	0%	7%	46%	47%	10%	19%	22%	49%
3	Lat Ceph	0%	3%	49%	48%	-	4%	23%	73%
4	C.T. Scan	19%	30%	44%	7%	46%	30%	22%	2%
5	Spiral C T scan	42%	51%	7%	-	81%	15%	3%	1%
6	CBCT	63%	36%	1%	-	87%	13%	-	-
7	ICGI	75%	25%	-	-	90%	9%	1%	-

Table no 5: Number of Clinician (in percentage) (n= 200) who judged ease of imaging documentation for each technique.

Sr. no	Imaging techniques judged	Easy to document	Difficult to document
1	IOPA	9%	91%
2	OPG	12%	88%
3	Lat Ceph	14%	86%
4	C.T. Scan	51%	49%
5	Spiral C T scan	81%	19%
6	CBCT	93%	7%
7	ICGI	91%	9%

Table no 6: Number of patient (in percentages) who responded to particularly advised imaging technique in relation to ease, time and expense of the process.

Imaging techniques	Patient's Response						
	Ease of the process		Time of the process		Expenses of the process		
	Comfortable	Uncomfortable	Quick	More	Expensive	Affordable	Cheap
IOPA (n=10)	-	100%	10%	90%	-	10%	90%
OPG (n=10)	30%	70%	30%	70%	-	80%	20%
Lat Ceph (n=10)	40%	60%	10%	90%	-	80%	20%
C.T. Scan (n=10)	20%	80%	20%	80%	60%	40%	-
Spiral C T scan (n=10)	40%	10%	70%	20%	70%	30%	-
CBCT (n=10)	90%	10%	90%	10%	80%	20%	-
ICGI (n=10)	100%	-	80%	20%	100%	-	-

Table No 7: Number of patient (in percentages) who responded to particularly advised imaging technique in relation to level of understanding of treatment plan and type of an approach.

Imaging techniques	Patient's response						
	Level of understanding of treatment plan				Type of an approach		
	Excellent	Good	Fair	Poor	Traditional	Advanced	Highly advanced
IOPA (n=10)	-	-	30%	70%	100%	-	-
OPG (n=10)	-	-	50%	50%	100%	-	-
Lat Ceph (n=10)	-	-	40%	60%	100%	-	-
C.T. Scan (n=10)	10%	70%	20%	-	30%	70%	-

Spiral C T scan (n=10)	80%	20%	-	-	-	60%	40%
CBCT (n=10)	90%	10%	-	-	-	40%	60%
ICGI (n=1)	80%	20%	-	-	-	20%	80%

DISCUSSION:

Several radiographic imaging techniques are available for diagnosis and treatment planning of patient receiving dental implants. It ranges from standard projections commonly available in dental clinic to more complex radiographic technique typically available only in radiology centre. Standard projection includes Intra-oral periapical radiograph IOPA, panoramic (OPG) and lateral cephalometric (Lat Ceph.) extra oral radiographs. More complexing radiography includes computed tomography (CT), Spiral CT, Cone beam CT and interactive computer guided implantology (ICGI).¹⁻⁶

Periapical, panoramic and lateral cephalometric radiography provides 2-dimensional image of three dimensional object and do not provide any information of the buccal –lingual dimension of the alveolar ridge, which is important factor in determining the diameter of the proposed implant. Also, structures that are distinctly separated in buccal-lingual direction appear to be overlapping. Nonetheless, these radiographs are relatively inexpensive, easy to acquire and offers low exposure to x-ray radiation.

Peri-apical radiograph (IOPA) images are restricted to limited area only (3-4 teeth / image) on contrary to OPG and Lat Ceph which offers complete visualisation of both the jaws and there relationship with each other and skull. However, OPG and Lat Ceph gives unpredictable magnification and distortion error. Hence, should not be used for detailed measurement of proposed implant sites.

Cross sectional imaging modalities for dental implant therapy includes conventional CT, spiral CT, CBCT and ICGI. Cross sectional imaging provides 3 –dimensional view of the whole arch in digitalized format (with measurement facility) with predictable magnification, high contrast, accuracy and reproducibility but are relatively expensive and requires higher x-ray exposure dose except CBCT⁷.

Maximum clinician judged CBCT, ICGI followed by Spiral CT then conventional CT Scan as a better imaging modalities with respect to maneuverability, accuracy, reproducibility and reliability and, ease of understanding of target anatomy, ease of imaging documentation and ability to increase dental awareness. This judgment of clinician is in favour of studies supporting reliability of CBCT, ICGI and CT in planning dental implants.^{8 - 15} However, clinician judged OPG and Lat Ceph radiographs to be least accurate, reproducible and reliable for planning dental implant. This was in correlation with finding of Schwarz MS et al⁵ which suggested that accurate assessment of hard tissue morphology and density was impossible conventional projection radiography because of the variable distortions occurring in different parts of the panoramic radiograph.

Though most of the clinicians reported IOPA to be most accessible at clinic but patient responded it to be most uncomfortable technique due to frequent placement of film intra-orally for multiple sites. Among cross sectional

conventional CT scan was reported to be most uncomfortable during planning of multiple sites due to frequent need of changing of position.

Jacob et al ¹⁶ demonstrated that interactive, reformatted cross-sectional images, used together with 3-dimensional reconstruction planning (ICGI), give a better prognostic value than conventional cross-sectional CT planning for implant lengths.

CBCT provides precise measurement of distance between alveolar ridge and vital structure like mandibular canal^{9, 17}, Maxillary sinus ¹⁰, etc... Thus helps in determining the safety zone.

C.C de Menezes et al ¹⁸ showed that measurement of buccal and lingual bony plate was highly reproducible using cone beam computed tomography.

All radiographic imaging must be dealt with exposure to x ray radiation “as low as reasonably achievable” (ALARA), to avoid unwanted complication and maximize treatment outcomes. The detail of effective dose of ionizing radiation received from common projection during evaluation of implant is in Table No 5.

Table no 5: Effective dose of ionizing radiation received from different imaging modalities.⁷

Sr No	Modality	Effective Dose
1.	Full mouth x-ray series	35-44
2.	Panoramic radiography	5-30
3.	Computed tomography of head	1202-3324
4.	Cone beam computed tomography	19.9-42.1

CBCT scanning delivers an effective dose approximately 50 to 100 times less than the radiation dose delivered during conventional CT. ⁷ Evidence suggests that CBCT offers precise and detailed evaluation of implant site by providing accurate cross sectional imaging and 3-dimensional visualization of anatomic structures, at a relatively lower and safer dose.

Based on the result of present study, clinicians in Mumbai highly preferred the cross-sectional imaging over conventional radiographic imaging for diagnosis and treatment planning of implant. Among cross-sectional imaging, preference was greater for CBCT, ICGI and Spiral CT scan than conventional CT scan. Patient responded and tolerated the procedure very well for the cross sectional imaging than conventional radiographic imaging modalities. However, expense and accessibility were the only negative factor for cross-sectional imaging.

Thus by creating awareness and imparting knowledge to new clinicians about the use of advanced imaging modalities for planning of dental implant, it will be highly possible to improve the quality of treatment delivered to the patient. The clinician and patient response for cone beam Computed tomography either individually or associated with Interactive computer guided implantology, and Spiral CT scan were magnificent over conventional radiography for treatment planning of dental implant.

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Date of manuscript submission: 2 July 2012

Date of initial approval: 5 August 2012

Date of Peer review approval: 29 August 2012

Date of final draft preparation: 30 August 2012

Date of Publication: 5 September 2012

Conflict of Interest: Nil, Source of Support: Nil.