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Original Research

Awareness and knowledge about 3-d scanning and printing among dental practitioners in India- A web based survey

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ABSRACT:

Aims and objectives: The present study aims to assess the awareness, knowledge, and attitude towards 3D scanning and printing among dental practitioners. **Methodology:** A web-based cross- sectional survey using a closed ended questionnaire was sent to 460 registered dental professionals. The google form-based questionnaire link was distributed among dental practitioners, academicians and post graduates. A total of 280 participants completed the survey, with a responses rate was 60.8%. **Results and conclusion:** The results of the present study represented level of knowledge, awareness and, inclination to use the technology of 3D scanning and printing among the dentists of India. Within the limitations of the present study, it may be concluded there is still a dearth of thorough knowledge and a lack of willingness to implement this advanced technology into routine clinical practice which emphasises the need to create continuous awareness through regular education programs so that this novel technology seamlessly becomes a part of regular dental practice. **Keywords-** 3D printing, CAD-CAM, digital dentistry, additive manufacturing, STL.

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INTRODUCTION

In modern day dentistry, digitalisation has brought about a shift in traditional dental practice, which now relies majorly on digital technology, software applications and computer aided designing and machining (CAD-CAM).The incorporation of 3D printing technology has altered the face of dentistry over the past decade. Being a versatile technique, it allows the formulation of fully automated, tailormade treatment plans.^[1]

Dentistry has a long association with subtractive manufacturing, more commonly described as milling which involves removal of material from an object. ^[2]3D printing, in contrast, is generally used to describe a manufacturing approach that builds objects by adding layers in sequence to form a multi-layered object.^[3]With its increasing popularity in the field of medicine and dentistry, 3D printing uses intricate algorithmic designs and artificial intelligence to aid in modelling objects or tissues reproducing it exactly as

per the clinician's desire.² In the field of medicine, it has helped to synthesize customised scaffold regeneration in cardiology, neurosurgery, plastic surgery and in craniomaxillofacial surgery and for bone regeneration. ^[4,5]In dentistry, 3D printing has profoundly altered many aspects of reconstructive, restorative, and implant dentistry.^[1] It has streamlined the difficult workflow in the fields of prosthodontics, periodontics, orthodontics, endodontics, and implantology. ^[2,6] 3D printing has led to expedited, less invasive and more predictable procedures which have revolutionized dental healthcare ensuring better treatment outcomes.^[2]There is limited scientific literature available which assesses the knowledge and attitude towards implementation of 3-D technology in routine dental practice. The present survey, therefore, was conducted to assess the knowledge, approach and willingness of dental practitioners to incorporate 3D printing into their routine dental practice.

MATERIALS AND METHOD

A cross-sectional, multiple-choice questionnaire was developed and validity was established through pilot study. A link was created programmatically and the online questionnaire as google form was personally delivered to 460 dental professionals in India. A total of 280 participants completed the survey, with a response rate of 60.8%. Questions were framed based on knowledge and attitude towards 3D printing.

STATISTICAL ANALYSIS

Data was entered into excel sheet and analysed using SPSS 21.0 version. Descriptive Statistics.

RESULTS

This is a simple observational study. The findings were tabulated, into 2 tables divided into knowledge based and attitude-based questions. to implement 3D scanning and printing.

 Table 1. Response of the participants towards knowledge-based questions

	Question	Response	Frequency	Percentage
1.	Are you aware of	Not aware	20	7.1
	terminologies like 3 D	Aware but do not practice	180	64.3
	printing?	Aware and practice	48	17.1
		Witnessed in institution / clinical practice	44	15.7
2.	What are the sources of	Articles/ books	180	64.3
	information?	Conference/ CDE	126	45.0
		Lectures(online/onsite)	116	41.4
		Social media	140	50.0
3.	What does the term 3D		214	76.4
	signify?	Width, height and depth of an object.		
		New technology of 3d objects.	56	20.0
		The way in which images are created.	52	18.6
		None of the above.	6	2.1
4.	The steps for making a 3 D	Idea- design- export- print.	190	67.9
	printed object?	Design- idea- print—export	70	25.0
		Design- print- idea- export.	6	2.1
		Idea- print- design-export	16	5.7
5.	What part according to you	User interface	48	17.1
	is the brain of the 3 D	Frame	36	12.9
	printer?	Extruder	30	10.7
		Motherboard	178	63.6
6.	What according to you is the	Use of 3-dimensional CAD data for	140	50.0
	technology involved in 3 D	production of 3D physical models		
	printing?	Addition of multiple layers of materials one	156	55.7
		by one under computer control to create 3-		
		dimensional object		
		Machining techniques in which cutter	22	7.9
		generates complex geometrics forms which		
		are typically non angular		
		Cosmetic dental procedure that corrects	16	5.7
		teeth imperfections and restores dental		
		appearance		
7.	3 D printing employs which	Stereo lithography	140	50.0
	of the following technology?	Fused Deposition Modelling (FDM)	108	38.6
		Multi Jet Printing (MJP)	102	36.4
		Selective Laser Sintering (SLS)	112	40.0
0	With the second state of t	Subtractive machining	30	12.9
8.	What materials, according to		204	72.9
	you are used in 3d printing?	<u>Zirconia</u>	222	19.3
		Kesins Comparis	234	83.0
	2 Descriptions is also lar	LID meinting	1/0	00.7
9.	ים prinung is also known	AD printing	30	20.0
	as	3 design printing	80	28.0
		Insufficient knowledge and training	134	47.9
10	XX71 / 1 1 1	None of the above	26	9.3
10.	what idea do you have	DOC	40	14.3

about the file format that is	PDF	60	21.4
exported to print?	JPEG	46	16.4
	STL	164	58.6
11. What do you think	Filament colour.	134	47.9
determines the color of the	What ink you put in.	64	22.9
objects we print?	The 3D printer.	90	32.1
	Spool holder.	26	9.3

Table 2. Response of the participants towards attitude-based questions

	Question	Response	Frequency	Percentage
1.	What according to you are	Pulp canal obliteration	148	52.9
	the clinical situations where	Endodontic surgery	186	66.4
	3 D printing is applied in	Auto transplantation	106	37.9
	dentistry?	Instrument retrieval	88	31.4
		Smile designing	160	57.1
		Maxillofacial surgery	146	52.1
		Dental prosthesis	196	70.0
2.	According to your which	Pulp canal obliteration	140	50.0
	cases can be treated by 3D	Endodontic surgery``	216	77.1
	guided endodontics?	Instrument retrieval	126	45.0
		Root canal obturation	90	32.1
3.	What do you think are the	Accurate localization of osteotomies	186	66.4
	advantages of 3 D printing	Minimize risk of sinus perforation	180	64.3
	in endodontic micro	Controls bleeding	60	21.4
	surgery?	Improved soft tissue handling	112	40.0
		Prevention of nerve injury	140	50.0
		Enhanced visualization	156	55.7
4.	What according to you are	Save the cost of storage of human cadavers	226	80.7
	the advantages of 3 D	Serves as alternative to natural dentition	220	78.6
	printing in relation to	Create interactive 3 D virtual simulations of	246	87.9
	educational models and	teeth and skeletal tissues (haptic simulation)		
~	clinical simulation?		21.6	77.1
5.	What do you think are the	Less chances of latrogenic errors	216	77.1
	advantages of application of	Saves procedural time	182	65.0
	3D printing over	Minimizes the wastage of material	118	42.1
	conventional methods in	More accurate	214	76.4
6	chinear set up?	Easy fabrication	106	37.9
6.	What do you think are the	Technical setup for software development	156	55.7
	present challenges in 3 D	Manufacturing cost	192	68.6
	printing?	Patient compliance: risk of litigation	60	21.4
		Longer production timelines	66	23.6
		Lack of expertise	148	52.9
		Data storage requirements	54	19.3
_		Other	2	0.7
7.	What could be the reason for	Economically not viable	174	62.1
	not opting 3 D printing in	Inadequate lab support	114	40.7
	daily practice?	Insufficient knowledge and training	144	51.4
		Any other	44	15.7
8.	Do you think high cost of 3	Yes	204	72.9
	D printing technique	No	34	12.1
	acceptance by patient?	Not sure	42	15.0

DISCUSSION

3D technology, though recently introduced in routine dentistry, was first developed and used in late 1980's and 1990's. ^[2] This technology has its resonance in dentistry, and with time, advancements in 3D imaging

and modelling, in conjunction with recent scanning techniques along with CBCT, has added a new dimension to the field of dentistry.In the present survey 240 participants responded, which included 39.9% postgraduates, 29.3% clinicians, and 11.4 %

academicians, out of which 64.3% were aware of the term 3 D printing, 7.1% were not aware of this technology and only 17.1% practiced it in their routine treatment.3D printing involves four steps involving idea, design, export and print (van Nort 2012, Kim et al.2016) with motherboard being the brain of 3D printer.^[7] The objects (models and guide) fabricated using additive manufacturing are techniques which involves successive curing of material in vertical layers [8] that fuse together on an ascending or descending platform by employing the technique of stereolithography (STL). [9,10,11] In the present survey, nearly half of participants (55.7%) believed that the process involved addition of multiple lavers of materials under computer control, while the other half (50%) believed that the printer uses CAD data for fabrication of 3D physical models.58.6% dentists were aware of the STL format and maximum of 47.9% knew that filament colour determines the object colour. Models of different materials like cements, metals, resins and zirconia can be fabricated using this technique and in present study, maximum participants (83.6%) considered resins as the material of choice in 3D printing followed by zirconia, metals and cements.^{[1}The various specialities where advanced application of 3D printing has been effectively applied are maxillofacial surgery, prosthodontics, periodontics, orthodontics, endodontics and implantology. ^[2,6] Use of 3D printing was found to be advantageous in cases of auto transplantation by 37.9% clinicians, smile designing by 57.1% and for fabrication of dental prosthesis by 70% practitioners. According to PK Shah and BS Chong, this technology has played a pivotal role in the field of the endodontics, where it has been proven to be a milestone in surgical as well as nonsurgical approaches, making the treatment of complicated cases involving calcified canals and dilacerated roots more feasible. It prevents procedural errors in roots with complex anatomic structures or those covered by thick cortical bone. This has been the reason why 3D printing has gained popularity in surgical endodontics and cases requiring retreatment.^[12] Use of 3D printing was found to be beneficial in cases of the ^{pulp} canal obliteration by 52.9% dentists, in instrument retrieval by 31.4% and 77% participants identified endodontic surgery to be the most common area where 3D printing is used followed by pulp canal obliteration (52%) and instrument retrieval (31.4%). In surgical cases, 3D printing brings down the risk factors avoiding encroachment into the neurovascular bundle of the adjacent area and also allows better visualization, clinical efficiency, precision with decreased risk of sinus perforation.^[13] 66.4% participants believed that 3D printing allows accurate localization of osteotomy site and also minimizes the risk of sinus perforation (64.3%), prevents nerve injury (50%) and allows enhanced visualization (55.7%)The application of 3D printing technology in haptic simulators has reinforced academic teaching,

acquisition of psychomotor skills, ergonomic chair side positioning along with creation of large number of prototypes for preclinical research (Pollens P, Grebe A, Petersen A et al. 2010). Several researches done by Kfir et al 2013, Bahcall 2014, Kato and Kamio 2015, Marending et al 2016, found that tooth prototype used for simulation exercises are more beneficial over extracted teeth, as the custom designed models have shown to enhance the preclinical residency exercises and research activities involving shaping ability and stress values of different rotary files, evaluating irrigating techniques. Majority of respondents in the present study believed that it saves storage the cost of cadavers (80.7%) and 78.6% found it to effectively serve as an alternative of natural dentition.^[13]Based on the results of this survey various practitioners agreed that 3D printing helps to overcome drawbacks of conventional methods. It helps to reduce iatrogenic errors, saves procedural time and allows greater accuracy of procedure and fabrication with minimal wastage easy of material.^[2]However, there are various challenges involved with the use of 3D printing including advanced training and expertise, finical constraints, data storage.^[13] More than half of the practitioners (68.6%) identified cost and need of large setup as the major challenge and the other half, i.e., 52.9% practitioners stated lack of expertise as the main reason for its limited use. Over the past few years, literature on 3D printing has been included in textbooks, lecture sessions in different conferences and webinars to create awareness on this promising tool among dental students and practitioners.

CONCLUSION

According to present survey, 64% clinicians are aware of the importance of 3 D Printing in dentistry, out of which, only 17 % clinicians implement this technology in routine clinical practice. The limited implementation of 3D technology in routine clinical practice may be attributed to the high cost incurred due to the expensive equipment and costly running materials and the need for trained technicians and skilled operators. Therefore, to incorporate 3D printing into routine dental practice, it is imperative to include it's training as a part of undergraduate and postgraduate curriculum along with conduction of Continuing Dental Education programs for regular upgradation of knowledge and skills.

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