



Original Research

**KNOWLEDGE, AWARENESS AND PRACTICE OF DIGITAL ORTHODONTICS
AMONG ORTHODONTISTS AND ORTHODONTIC RESIDENTS – A CROSS
SECTIONAL STUDY**

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ABSTRACT:

Introduction: In recent years, there has been a revolution in the use of technology across all fields, including medicine and dentistry. Significant technological advancements are being made in the field of orthodontics, which have enhanced patient and practitioner experience overall. This study aimed to assess knowledge, awareness, and practice of digital orthodontics among orthodontists and orthodontic residents through a questionnaire.

Materials And Methods: This cross-sectional study collected data using 20 questionnaires (pretested and prevalidated) by the experts. The questionnaire consists of socio-demographic information (5 questions) and a section asking about knowledge (9 questions), awareness (5 questions), and practice (6 questions) about digital orthodontics. The Final sample size was 360. Following content validation, the completed questionnaire was forwarded over social media platforms to the Orthodontic Study Group and distributed to orthodontists and orthodontic residents, and responses were collected. The data was assembled, organized, and subjected to statistical analysis using SPSS, IBM version 20.0. A chi-square test was performed for the quantitative variables.

Results: The findings showed that most participants were aware about digital orthodontics, and they also showed a promising trend towards incorporating digital orthodontics into routine clinical practice. A statistically significant difference was present regarding the knowledge about digital orthodontics between males and females (p value=0.024).

Conclusion: Orthodontic Residents and orthodontists demonstrated a positive attitude, acceptable knowledge, a good outlook and little experience with digital orthodontics.

Keywords- Digital orthodontics, CAD/CAM, Aligners, Artificial Intelligence, Intraoral scanners, digital impression.

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INTRODUCTION

The age of digitalization and innovation has hit the health care sector like an illuminating realization and the field of orthodontics is venturing more ahead in technological point of view in its new era. [1] In terms of concepts, biomaterials, and technology, orthodontics has advanced significantly from Angle's era to the modern nano robotic era. [2] In addition, several initiatives have been undertaken by various organizations for research and investment into digital orthodontics to offer a significant growth in dentistry.

Digital work flow is currently increasing in the orthodontic practice and has touched every aspect of orthodontics. It deals with paperless dentistry, study casts, analysis of dental malocclusion, software smile designing, virtual treatment planning simulation and for fabrication of orthodontic appliances. [3] This is done by tools like CAD/CAM technology, 3D printing, artificial intelligence, augmented and virtual reality, intraoral cameras and scanners, lasers, align-technology, tele dentistry. The advantages of Digital orthodontics is being more convenient to the patients as well as practitioners by reducing chair side time, fewer appointment visits and affordable treatments. This revolution has enormously assisted in overcoming previous communication hindrances, improving outcomes and subsequently increasing productivity such as Quickceph, Dolphin imaging software. [4]

Despite many benefits of the application of digital technologies, practice is one of the important factors that limits the efficient integration and utilization of these technologies in dentistry. Thus, a questionnaire tool was developed which aimed in evaluating knowledge, awareness and practice of digital orthodontics among orthodontist and orthodontic residents.

MATERIALS AND METHODS:

The institutional ethical committee approval was obtained from Sathyabama Dental College and Hospital, Chennai. The study was started after obtaining the ethical approval. This was a cross sectional survey conducted with pretested questionnaire comprising of 20 questions. The questionnaire was divided into four parts which includes,

- i. Socio demographic details (5),
- ii. knowledge based questions (9),
- iii. awareness based questions (5)
- iv. practice based questions (6)

A structured questionnaire was prepared, which was circulated through social media platforms such as WhatsApp, telegram, and email with the help of Google Forms. The inclusion criteria for our study were orthodontists and orthodontic residents and exclusion criteria were general dentist and other specialty dentist. Sample size estimation was done using G* power software (version 3.1) by keeping the alpha probability as 0.05, with an effect size of 0.2 and power 0.95 which accounted for 312 participants. The study population comprised of 360 members, out of which 191 orthodontists and 169 orthodontic residents. The questionnaire was validated for relevance of questions particular to the topic of the survey (face validity) and for the reliability of the options provided (content validity) with a content validity index score (CVIs) of 0.72 by the Faculty from the Public Health Dentistry, Sathyabama Dental College and Hospital, Chennai along with subject experts. The

responses of the questionnaire were accepted till a period of 30 days. The reminder messages were sent to maximum of 3 times with interval of 2 days to all the participants. Respondents could submit their answers only after answering all the questions. The data was assembled, organized and entered in Microsoft excel sheet and subjected to statistical analysis using statistical package for social sciences (SPSS, IBM version 20.0). Chi Square test was performed for the quantitative variables.

RESULTS

The present study was carried out to assess the knowledge, awareness and practice of digital orthodontics among the orthodontists and orthodontic residents. Chi-square test was used to ascertain the inferential statistics between the different responses of the individuals. The statistical constant was fixed at $p < 0.05$.

1. Demographic Characteristics of the study population- Figures 1 and 2 show that the distribution of the gender and category of population was not statistically significant inferring that they were almost at par. These were graphically represented in the subsequent figures.

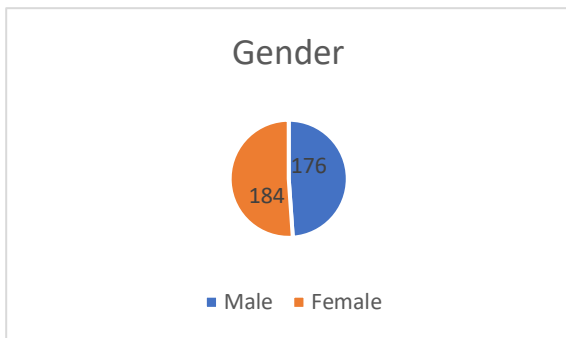


FIGURE 1 – GENDER DISTRIBUTION

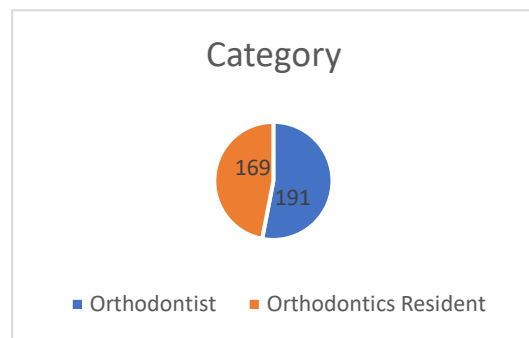


FIGURE 2–CATEGORY DISTRIBUTION

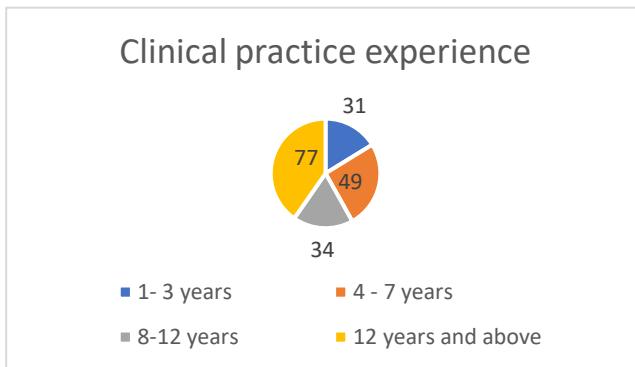


FIGURE 3 – CLINICAL EXPERIENCE DISTRIBUTION

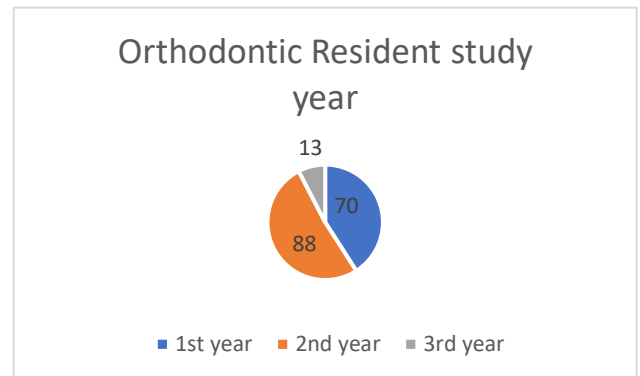


FIGURE 4 – ORTHODONTIC RESIDENT YEAR OF STUDY DISTRIBUTION

Figures 3 and 4 shows that the clinical practice experience and year of resident showed a statistically significant variation. These were graphically represented in the subsequent figures.

TABLE 1 - DOMAIN SCORE COMPARISON BETWEEN DEMOGRAPHIC VARIABLE

		Knowledge	Awareness	Practice
		Mean	Mean	Mean
Gender	Male	23.21	6.09	12.24
	Female	24.22	5.93	11.84
F Score		5.122	1.284	2.174
P-Value		0.024*	.258	.141
Category	Orthodontist	21.32	6.10	12.90
	Orthodontics Resident	26.44	5.90	11.07
F Score		200.784	2.051	52.609
P Value		<0.0001*	.153	<0.0001*
Clinical practice experience	1- 3 years	26.00	6.61	8.93
	4 - 7 years	20.18	7.08	12.73
	8-12 years	19.05	6.88	15.02
	12 years and above	21.23	5.00	13.76
F Score		36.502	109.209	82.631
P Value		<0.0001*	<0.0001*	<0.0001*
Orthodontic Resident study year	1st year	24.05	4.42	9.47
	2nd year	28.19	6.97	12.57
	3rd year	27.15	6.69	8.61
F Score		51.829	152.869	114.270
P Value		<0.0001*	<0.0001*	<0.0001*

*statistically significant

2. Knowledge related responses of the study population-

There was a statistically significant difference between the responses of the participants for all the questions. There were 355 among 360 participants who were aware of digital orthodontics and 5 likely unknown. iTero element 2 was described as the most aware intraoral scanner with a 70.8% success rate. 3D printing and intraoral scanners were reported to be the most feasible technology with 21.1% of the study population. CEREC with the highest percentile of 41.4 was reported to be a better CAD/CAM system according to the study. About 74.2% of responders like to increase their knowledge about these technologies through hands-on, lectures and workshops.

TABLE 2- KNOWLEDGE RELATED RESPONSES OF THE STUDY POPULATION

		Frequency (N)	Percentage%	Chi Square	P Value
Aware of Digital Orthodontics?	No	5	1.4	340.3	<0.0001*
	Yes	355	98.6		
Aware of any of these intraoral scanners	Trios	240	66.7	239.5	<0.0001*
	iTero element 2	255	70.8		
	Care stream	61	16.9		
	Sirona	199	55.3		
	3M Tru def	86	23.9		
	Planmeca Emerald scanner	126	35.0		
	None of the above	6	1.7		
Which technology is more feasible	Intra-oral scanners	2	.6	1235.1	<0.0001*
	Cephalometric tracing software's	2	.6		
	3D printing	1	.3		
	Digital models, Intraoral scanners	2	.6		
	Digital models, Intraoral scanners, Cephalometric tracing	37	10.3		
	Digital models, Intraoral scanners, Digital cephalometric models, All of the above	1	.3		
	3D printing, Digital models, Intraoral scanners	1	.3		
	3D printing, Intraoral scanners	76	21.1		
	All of the above	238	66.1		

Advantage Of CAD/CAM In The Clinical Scenario	Eliminates the problems associated with impression making	104	28.9	409.2	<0.0001*
	Can review your preparation and modify it at the same time	115	31.9		
	Immediate data transfer and retrievability of scan date	289	80.3		
	Accurate and precise fit of the orthodontic appliance	244	67.8		
	Ease in laboratory authorization and communication	195	54.2		
	Accurate and precise orthodontic tooth movement	19	5.3		
Better CAD/CAM systems	CEREC	149	41.4	692.7	<0.0001*
	DCS Precident	95	26.4		
	DCS Precident, CEREC	79	21.9		
	Exocad	1	.3		
	Lava	12	3.3		
	Lava, CEREC	16	4.4		
	Lava, DCS Precident, CEREC	5	1.4		
	Don't know much	1	.3		
	No Knowledge	1	.3		
	Not aware	1	.3		
Orthodontic Application useful clinical practice	Diagnostic apps	76	21.1		<0.0001*
	Model analysis apps	95	26.4		
	Patient reminder apps	44	12.2		
	Progress tracker apps	145	40.3		

Advantage of using AI in Orthodontics	Improved and modern interface for human interaction	65	18.1	200.5	<0.0001*
	New technique to resolve unique problems	79	22		
	Manages the information properly than humans	97	26.9		
	All of them	119	33.1		
Increase your knowledge	Hands On	41	11.4	467.6	<0.0001*
	Workshops	17	4.7		
	Lectures	35	9.7		
	All of them	267	74.2		
Significant Role In Orthodontics In Future?	No	179	49.7	0.011	0.916
	Yes	181	50.3		

3. Awareness related responses of the study population

About 80.8% of the respondents were aware that combining orthodontic materials with nano-particles prevents microbial adhesion. About 60% of responders would like to invest more in intraoral scanners. Dolphin imaging software is mostly used to anticipate orthognathic surgery by clinicians with 60.8%. 98.6% of them favored curriculum integration of digital orthodontics.

TABLE 3 - AWARENESS RELATED RESPONSES OF THE STUDY POPULATION

		Frequency (N)	Percentage (%)	F Score	P Value
Digital technologies used in orthodontics would you like to invest in?	Digital impressions	54	15.0	256.99	<0.0001*
	Intraoral scanners	216	60.0		
	Digital cephalometric analysis	86	23.9		
	All of the above	100	27.8		
	3D printing	11	3.1		
	Digitally fabricated	121	33.6		

	appliances				
Orthognathic Surgical prediction software are you aware of?	Dentofacial planner plus	82	22.8	226.533	<0.0001*
	Dolphin imaging software	219	60.8		
	None of the above	12	3.3		
	Orthodontics prediction analysis (OPAL)	179	49.7		
	Quick ceph	62	17.2		
	All of the above	87	24.2		
Include digital orthodontics as a part of curriculum	No	5	1.4	340.278	<0.0001*
	Yes	355	98.6		
Method of taking impression is convenient for both clinician and patient	Conventional	5	1.4	503.750	<0.0001*
	Digital	320	88.9		
	Both	35	9.7		

4. Practice related responses of the study population

Invisalign was the most popular aligner system with 90.3% utilized in clinical practice. About 80.6% of participants take impressions using both conventional and digital techniques. The participants employed 3d printing to create diagnostic models & casts (38.9%) and pre-surgical assessment (34.4%). 57.5% stated that optical sensors were the intra-oral micro-sensors employed in clinical practice.

TABLE 4 - PRACTICE RELATED RESPONSES OF THE STUDY POPULATION

		Frequency (N)	Percentage (%)	F Score	P Value
Which Aligner system do you use in your clinical practice ?	3 shape software in house aligner	1	.3	259.133	<0.0001*
	Byte	38	10.6		
	Clear correct	106	29.4		
	Clear path	244	67.8		
	Flash	128	35.6		
	Illusion	4	1.1		
	Invisalign	325	90.3		
	LMS	1	.3		
	Odonto	2	.6		
	Spark	37	10.3		
	V clear	1	.3		
	X align	1	.3		
What method do you practice for recording impression of patients?	Conventional	64	17.8	375.267	<0.0001*
	Digital	6	1.7		
	Both	290	80.6		
Which method do you practice for radiographic analysis?	Digital	18	5.0	283.650	<0.0001*
	Manual	75	20.8		
	Both	267	74.2		
3d Printing application used in your clinic	Diagnostic models and cast	140	38.9	488.367	<0.0001*
	Pre surgical assessment /planning for maxillofacial reconstruction surgeries	124	34.4		
	All of the above	128	35.6		
	Surgical guides for mini implants	43	11.9		
Intraoral micro-sensors would you like to use in your clinical practice?	I'm unaware	95	26.4	818.806	<0.0001*
	Optical sensor	207	57.5		
	Force matrix sensor	112	31.1		
	Strain sensor	38	10.6		
	Piezoelectric sensor	71	19.7		
	None of the above	4	1.1		

	Stress sensor	40	11.1		
	Retention sensor	193	53.6		
Do you use any of the technology at your work place ?	No	23	6.4	273.878	<0.0001*
	Yes	337	93.6		

DISCUSSION

The biggest breakthrough in the field of dentistry in recent years has been the advent of digital innovation. Dentists living in a generation where digital revolution has increased exponentially, making processes easier, less time consuming and laborious procedures. Over the last decade, the discipline of orthodontics has evolved by leaps and bounds, with orthodontists beginning to integrate technology and most are already well established in practice. There have been advancements in orthodontic brackets, bonding agents, digital imaging systems, the use of micro implants, and the increasing scope of using intraoral scanners, 3D printers for the manufacturing of aligners.^[5-9] The study aimed to assess the knowledge, awareness and practice of digital orthodontics among orthodontists and orthodontic residents through a questionnaire.

3D printing and intraoral scanners are indeed the most used digital technology as they both are considered most feasible technology by majority of the participants. 3D printing, a rapidly evolving technology is now widely used in dentistry. Parikh Maitry et al ^[10] in their study stated that 3D printing has absolutely brought positive changes in orthodontic diagnosis and treatment modalities and later it has been evolved as “Diagnostic tool” in their routine practice and the respondents highly favoured the use of 3D printers for diagnostic models and casts (38.9%).

In our present study, Immediate data transfer and retrievability of the scanned data at any point of time were considered as major advantage of CAD/CAM in the clinical scenario with the response rate of 80.3% while 67.8% felt that accurate and precise fit of orthodontic appliance was major advantage. Jyotsna A, et al ^[11] in her study stated that "improving reproducibility, efficiency, and quality of orthodontic treatment" sums up the ultimate objective of using CAD/CAM technology to the field of orthodontics.

The study population was most familiar with iTero element 2 and Trios intraoral scanners. Amornvit et al ^[12] have stated that the iTero element and Trios scanning technology is the faster scanning technology that captures image by focusing on an optical light beam with high resolution visual images with improved accuracy and fewer distortions. Hence forth, it is now quite popular among orthodontists and the residents.

Traditional braces and aligners are giving way to sensor-based treatments that promise more precision, comfort, and efficiency. In the conducted survey it has been reported that Optic sensors are the intra-oral micro-sensors that are used more in clinical practice. Aadhirai et al ^[13] has stated that these innovative tools track tooth movement using sensors and artificial intelligence algorithms that would monitor tooth movement and adjust the forces accordingly.

Aligners have taken over the present era in orthodontics with an upsurge in the demand for esthetic treatment over traditional braces. There are a few aligner systems that are used commonly worldwide over which 90% of

the study population have chosen Invisalign for their clinical practice. Zakirulla et al^[14] found that 71% believed that Invisalign treatment produces superior results to traditional braces.

Maximum respondents preferred both, conventional and Digital Impression making techniques with 80.6% where 88.9% of the participants chose that Digital impression making technique was more convenient for both the clinician and patient. The use of digital flow and digital impressions is certainly very widespread, some orthodontic devices, such as aligners, if produced from digital impressions, allow the dentist to save a lot of time and to reduce the costs.^[15]

In our study, all orthodontists and orthodontic residents responded regarding investment in digital technologies used in orthodontics and almost all of them had a wish to invest in intraoral scanners (60%) and Digitally fabricated appliances (33.6%), whereas the least one was 3D printing (3.1%). The adoption of these technologies by clinicians is reduced because of the high cost-effectiveness that could be a barrier. Henceforth, the practice of these digital technologies in clinical practice is reduced. Kulkarni et al^[16] state that the creation of specialized marketing organizations can encourage and facilitate the proper integration of new technologies into standard clinical practice.

In the present study, 98.6% of the respondents stated that digital orthodontics can be included as a part of the curriculum. Sharab et al^[17] in his study state that there is a positive attitude toward digital dentistry and enthusiasm for learning emerging technologies in the dental field. Both orthodontists and orthodontic residents have positively stated that digital technology plays a significant role in the future of orthodontics.

CONCLUSIONS

Following conclusions can be drawn from this study:

- i. Orthodontists and orthodontic residents demonstrated an acceptable understanding of the digital revolution.
- ii. Females had higher scores for knowledge than males. Orthodontics residents had better knowledge scores while the awareness and practice scores were better for orthodontists.
- iii. Study participants have a favorable opinion of digital dentistry and want to invest in various technologies in the future. It is not widely used, mostly because of its significant and necessary investment.
- iv. Knowledge and awareness can be improved via workshops, lectures, hands-on, and incorporating into the dental curriculum.

DECLARATION OF CONFLICT OF INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship and or publication of this article.

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