Knowledge, attitude, and practice on 3D printing among orthodontist in India – An online questionnaire study

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ABSTRACT

The aim of this paper is to assess Knowledge, attitude, and practice on 3D printing among orthodontist in India. Orthodontists who were registered in Indian Orthodontic Society and practicing in India were included in this study. A survey google forms online tool was utilized in this study. Responses which were received by the orthodontists were included for evaluation. Amongst 2200 orthodontists only 800 orthodontists responded to the questionnaire. A total of 89% of respondents indicated that they heard of 3D printing used specifically for Dento maxillofacial region. A total of 83% practitioner think 3D printing has advantages over other Digital Imaging Modalities and 47.5% used 3D printing in clinical orthodontic practice as a diagnostic tool. The present study shows better awareness of 3D printing among orthodontist and this study suggests that more knowledge should be gained on this emerging new technology for better diagnosis and treatment planning.

Keywords— 3D printing, Attitude, Knowledge, Orthodontist, Practice, Questionnaire

1. INTRODUCTION

Diagnosis, treatment planning, and evaluation of treatment outcomes in orthodontics are routinely done with the help of radiographs. Radiographic imaging is essentially two-dimensional (2D) imaging of a three-dimensional (3D) object. Radiographic imaging is an integral component of the overall assessment of the orthodontic patient. The introduction of cone beams computed tomography (CBCT) to orthodontics facilitates the diagnostic and treatment planning process by providing three-dimensional information of the anatomy and morphology of the maxillofacial complex. [1]

Extra-oral radiographs are invaluable diagnostic tools in orthodontic treatment; lateral cephalometric radiographs can provide information on the structural relationships between bones, teeth, and airways. Most practitioners favour the use of digital radiographic techniques, which are being timed effective, use low doses of radiation, eliminate the requirement for chemicals and development processes, and facilitate straightforward data storage and ease of communication with colleagues. Disadvantages include the high equipment costs and provision of a two-, rather than three-, dimensional (3D) view.

3D views can be obtained using computed tomography (CT). In the field of dentistry, CT scanners have typically not been used because of concerns regarding radiation dose and cost. By the early 2000s, commercially available cone beam CT (CBCT) had become popular for the visualization of oral and maxillofacial regions. CBCT has several advantages over conventional CT, including reduced cost and space requirements, a more rapid scan time, and reduced beam application time to the head and neck. 3D visualisation of the craniofacial complex can improve orthodontic treatment planning, airway analysis, evaluation of temporomandibular joint (TMJ) dysfunction, orthognathic surgical planning, and understand facial asymmetry. [2]

A newer method- 3D printing has emerged and transformed diagnosis and treatment in dentistry and in orthodontics. A three-dimensional (3-D) printing is also known as additive manufacturing or desktop fabrication. It is a process of making 3-D solid objects from a digital file. The digital 3-D model is saved in STL format and then sent to the 3-D printer where the layer by layer design of an entire 3-D object is formed. This creation of the 3-D printed object is achieved using additive processes. Each of these layers can be observed as a thin sliced horizontal cross-section of the eventual object. [3]

However, 3D printing technologies are not all new; many modalities in use today were first developed and used in the late 1980s and 1990s Additive manufacturing, also known by a variety of names like rapid prototyping and 3D printing, has evolved over the ages and its uses have reached all fields of life. In 1993, Massachusetts Institute of Technology (MIT) patented "3-D Printing techniques." The origin of 3D printing can be dated back in 1984 when Charles Hull, an American Engineer, developed the world's first working 3-D printer and since then it is used in other fields such aerospace automobile medial engineering and construction industry. One of the earliest applications of 3D printing in dentistry is the production of an anatomical 'study model'. [3]

In orthodontics, treatment may be planned and appliances created, or wires bent robotically based upon a digital workflow using intraoral or laboratory optical scanning or even CBCT to capture patient data. The Invisalign®, system digitally realigns the patient's teeth to make a series of 3D printed models for the manufacture of 'aligners', which progressively reposition the teeth over a period of months/years. An example of printing with multiple materials is in the manufacture of 3D printed, indirect bracket bonding splints, printed in rigid and flexible materials for precise bracket placement using orthodontic CAD software (3Shape). As data travels through the internet, and smile design takes place in software, there are huge potential savings in time. Again, patient data may be digitally archived, and only printed when needed, with great savings in physical storage-space requirements. [4]

Use of this modern technology helps better to predict the treatment procedure and outcome of treatment in advance plus to show it to patients, also to make the patient aware of the need of treatment or for patient knowledge and satisfaction. It also helps the clinician for better precision and better control over the treatment to be provided. Having stated the transition of dentistry from manual to digitalization and replication the need to incorporate advanced tools for better and more satisfactory results.

Hence this survey was conducted to review how many orthodontists have already been using this modern technique or wish to use them in future. This study helped us to determine the knowledge, attitude and practice of orthodontists on 3d printing among orthodontists. Upcoming future is filled with abundant opportunities of technology which are aimed at improving the perspective as well as the satisfaction of the treatment outcome. No research has been conducted on the knowledge, attitude and practices on the use of 3D printing among orthodontist in India, and it is not known whether the knowledge, attitude and practice on the use of 3D printing in this country are similar to those in other developed countries. Hence this study is being planned. The aim of this study was to assess Knowledge, attitude and practice on 3D printing among orthodontist in India.

2. MATERIALS AND METHOD

A list of orthodontists, who are registered in Indian Orthodontic Society and their necessary details will be procured from the directory of Indian Orthodontic Society will be included in the study. Orthodontists who are registered in Indian Orthodontic Society and practising in India were included in the study. All participants included were from different zones (East, West, North, South) of India. The study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics and started after obtaining the clearance from the Sumandeep Vidyapeeth Institutional Ethics Committee (SVIEC no. SVIEC/ON/DENT/SRP/18112). A self-designed questionnaire was used in this study. The questionnaire was evaluated by subject experts and suggested modifications were incorporated. Validity and content of the questions were tested in a pilot survey done among seven orthodontists who practising orthodontics in clinical practice, wherein the questionnaires were filled and discussed. Depending on the responses of the pilot survey and using a single proportional formula, content validation was done. The questionnaire was found to be valid.

- Self-prepared questionnaire is validated using chi-square test.
- Chi-square is the sum of the squared difference between observed (O) and the expected (E) data (or the deviation, D), divided by the expected data in all possible categories and data entered in SPSS 20.0 with the level of significance is 0.05 (5%).
- Validated Questionnaire Results is 83.75% for this study.
- A survey google forms online tool was utilized in this study. A participant information sheet, an inform consent form and questionnaire was sent to the all participant. A reminder mail was given to all those orthodontists who did not respond every 4 weeks after the sending of a questionnaire to the orthodontist. Responses which were received till 12 weeks by the orthodontist were included for evaluation. The responses received were recorded and incorporated into the statistical analysis. The response which is received after 12 weeks will not be included in the study. Statistical analysis will be analysed using Chi-Square Test for categorical data.

3. RESULTS

Amongst 2200 orthodontists only 800 orthodontists responded to the questionnaire. Out of the total participants, 60 % (n = 480) were male respondents and 40 % (n = 320) were female respondents. (Graph: 1) The experience of practice as an orthodontist varied from 0 years to 25 years and above with the majority of orthodontist lying between 6 - 15 years 60 % (n = 480) and 0-5 years 17.5 % (n = 140). (Graph: 2) Table 1 describes the sample characteristics variables among surveyed orthodontists.

A total of 89% of respondents indicated that they heard of 3D printing used specifically for Dento maxillofacial region. A total of 50.5 % of respondents indicated that they obtain information regarding 3D printing from the internet;60% orthodontist attend workshops or courses regarding 3D Printing; 60.5% (484) respondents rarely used 3D printing for clinical practice. The most frequently cited Disadvantage of 3D printing was Expensive (70.5%), followed by Hard to perform (9.5%).

A total of 664 (83%) practitioner think 3D printing has advantages over other Digital Imaging Modalities.476 (59.5%) of orthodontist used 3D printing in routine orthodontic practice in all areas of dentistry.380 (47.5%) orthodontist think 1500-2000 Rs is the cost of 3D printing for one image.

A total of 47.5% used 3D printing in clinical orthodontic practice for Skeletal & Dental Assessment / Diagnostic purpose, For study models, Temporary Anchorage Device, Implant dentistry, Extraction of impacted teeth, For Pre-operative Orthognathic surgical treatment/splint fabrication, lingual orthodontics, Indirect Bonding. 96.5% orthodontist used 3D printing for a future orthodontic professional career. (p < 0.001; Table 1)

4. DISCUSSION

This study was carried out with the aim of assessing Knowledge, attitude and practice on 3D printing among orthodontist in India. Diagnosis, treatment planning, and evaluation of treatment outcomes in orthodontics are routinely done with the help of radiographs. A newer method- 3D printing has emerged and transformed diagnosis and treatment in dentistry and in orthodontics. [1]

A three-dimensional (3-D) printing is also known as additive manufacturing or desktop fabrication. It is a process of making 3-D solid objects from a digital file. The digital 3-D model is saved in STL format and then sent to the 3-D printer where the layer by layer design of an entire 3-D object is formed. This creation of the 3-D printed object is achieved using additive processes. Each of these layers can be observed as a thin sliced horizontal cross-section of the eventual object. [3]

No research has been conducted on the knowledge, attitude and practices on the use of 3D printing among orthodontist in India, and it is not known whether the knowledge, attitude and practice on the use of 3D printing in this country are similar to those in other developed countries. Thus, the study was planned.

Amongst 2200 orthodontists only 800 orthodontists responded to the questionnaire. A total of 89% of respondents indicated that they heard of 3D printing used specifically for Dento maxillofacial region. Approximately half (50.5 %) of our sample indicated that they obtain information regarding 3D printing from the internet; more than half (60%) of our sample indicated that they had learnt of 3D Printing from workshops or courses; 60.5% (484) respondents rarely used 3D printing for clinical practice. The disadvantage of 3D printing was Expensive (70.5%), followed by Hard to perform (9.5%).

A total of 47.5% used 3D printing in clinical orthodontic practice. 96.5% orthodontist used 3D printing for a future orthodontic professional career. 83% practitioner think 3D printing has advantages over other Digital Imaging Modalities. 59.5% of orthodontist used 3D printing in routine orthodontic practice in all areas of dentistry. 47.5% orthodontist think 1500-2000 Rs is the cost of 3D printing for one image. ($p < 0.001$; Table 1)

This study had some limitation of a few IOS members might not have received this survey if they do not have e-mail or do not use the e-mail address that they gave to the IOS.

This study conducted in order to review how many orthodontists have already been using this modern technique or wish to use them in future by members of the Indian Orthodontic Society. It also illustrates the current trends of 3d printing among orthodontists in India.

5. CONCLUSION

- This survey reports that orthodontist displayed adequate Knowledge, attitude and practice about 3D printing but few of the orthodontist did not use this to its greatest potential in their day-to-day practice in India.
- Although the 3D printing has absolutely brought positive changes to the ways in which orthodontist diagnosis the patients for their suitable treatment modalities and evolves as "Diagnostic tool" in their routine practice.
- The present study shows better awareness of 3D printing among orthodontist and this study suggests that more knowledge should be gained on this emerging new technology for better diagnosis and treatment planning.

6. REFERENCES

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[3] Mahmood S, Khader MA, Ali H. Applications of 3-D Printing in Orthodontics: A Review. Int J Sci Stud 2016;3(11): 267-70.
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APPENDIX

Table 1: Summary of characteristic variables among surveyed orthodontists

	Variable	Frequency	Percent	P Value
Gender	(a) Male (b) Female	480 320	60 40	< 0.001
How many years have you practised orthodontics?	(a) 0-5 years (b) 6-15 years (c) 16-25 years (d) > 25 years)	140 480 128 52	17.5 60 16 6.5	< 0.001
Questions regarding Knowledge				
Q: 1 Have you heard of 3D printing used specifically for Dento maxillofacial region?	Yes b) No	712 88	89 11	< 0.001

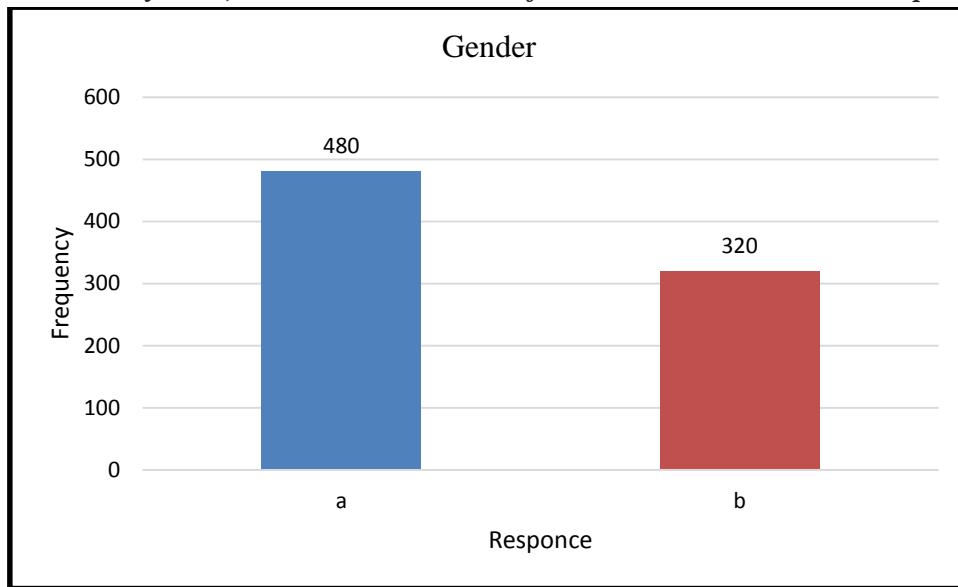| Q: 2. How did you obtain information regarding 3D printing in orthodontics? (Multiple answers allowed)	(a) Faculty lessons (b) Seminars (c) Internet (d) Others Please specify____	100 296 404	12.5 37 50.5	< 0.001
Q: 3. Do you have access to 3D printing for your clinical practice?	(a) Yes (b) No	572 228	71.5 28.5	< 0.001
Q: 4. Do you think it is necessary for a dental 3D printing unit to be available at your Locality?	(a) Yes (b) No	800 -	100 -	-
Q: 5. How often do you use 3D printing?	(a) Never (b) Rarely (c) Occasionally (d) Frequently (e) Always	96 484 172 48	12 60.5 21.5 6	< 0.001
Q: 6. Do you think 3D printing has advantages over other Digital Imaging Modalities?	(a) Yes (b) No	664 136	83 17	< 0.001
Q: 7. Did you attend any workshops or courses regarding 3D Printing?	(a) Yes (b) No	480 320	60 40	< 0.001
Questions regarding Attitude				
Q: 8. The disadvantage of 3D printing?	(a) Expensive (b) Hard to perform (c) None of above	564 76 160	70.5 9.5 20	< 0.001
Q: 9. To what extent do you think 3D printing will be used in routine orthodontic practice in the near future?	(a) In all areas of dentistry (b) For selected orthodontics applications. Which ones? (c) It will not be commonly used in routine orthodontic practice (d) No idea	476 172 152 -	59.5 21.5 19 -	< 0.001
10. Have you ever referred your patients for 3D printing for Any Diagnosis?	(a) Yes (b) No	216 584	27 73	< 0.001
Q: 11. What do you think is the cost of 3D printing for one image?	(a) 500-1000 Rs (b) 1500-2000 Rs (c) 2000 Rs above (d) No Idea	52 380 252 116	6.5 47.5 31.5 14.5	< 0.001
Q: 12. Are you willing to obtain any updated information regarding 3D printing?	(a) Yes (b) No	772 28	96.5 3.5	< 0.001
Questions regarding Practice				
Q: 13. For what cases would you choose to use 3D printing in your future clinical orthodontic practice? (Multiple responses are allowed)	(a) Skeletal & Dental Assessment / Diagnostic purpose (b) For study models (c) Temporary Anchorage Device. (d) Implant Dentistry (e) Extraction of impacted teeth (f) For Pre-operative Orthognathic surgical treatment/splint fabrication (g) lingual orthodontics (h) Indirect Bonding (i) All of the above (j) Other Please specify __ (k) No need	124 - - 200 96 - 380 - -	15.5 - - 25 12 - 47.5 - -	< 0.001
Q: 14. Would you use 3D printing in your future orthodontic professional career?	(a) Yes (b) No	772 28	96.5 3.5	< 0.001

Gender

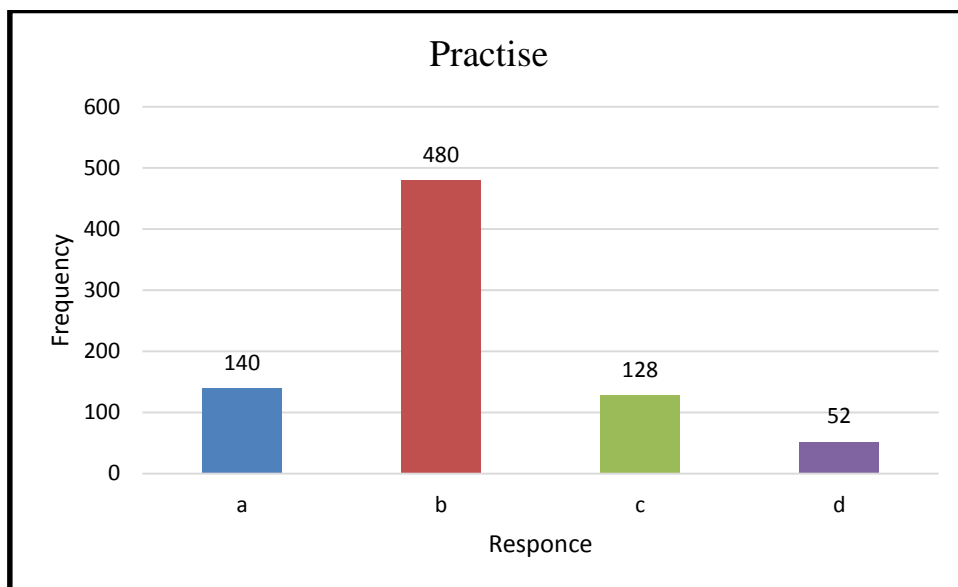**Fig. 1: Percentage of male and female ratio**

Practise

Fig. 2: Frequencies of experience of practice as an orthodontist