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IP Indian Journal of Orthodontics and Dentofacial Research

Journal homepage: https://www.ijodr.com/

Original Research Article

Comparative evaluation of accuracy, time and patient acceptance between intraoral scanner and conventional alginate impression technique – An invivo study

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ARTICLE INFO

Article history:
Received 14-06-2023
Accepted 07-08-2023
Available online 08-09-2023

Keywords:
Digital impression
Medit i500
Conventional impression
Bolton ratio
Intraoral scanner
Patient preference

ABSTRACT

Introduction: Orthodontists use various dental records such as dental models or casts for diagnosis and treatment planning which includes making of dental impressions and study casts. Conventional alginate impressions are challenging for the patients with extreme gag reflex, irritation & discomfort. Recently 3D technology has led to development of scanning and digital models, but one major concern has been the accuracy. So this study was done to compare the accuracy, time and patient acceptance between intraoral scanner and conventional alginate impression technique.

Materials and Methods: 15 patients were selected. Alginate impressions were made using zhermack neocolloid. The patients were subjected to digital scanning with Medit i500 intraoral scanner. Procedures were timed. After the impressions, each patient was asked to complete survey. Tooth width measurements were made using digital vernier caliper from stone models. In the second method digital images were measured using medit link software. Anterior and overall Bolton ratio was calculated to determine accuracy.

Results: Digital impressions are accurate and comparable to conventional impressions as tooth width measurements did not differ significantly. Conventional impression consumed more time. Patients preferred digital impressions.

Conclusion: Intraoral scanners are accepted by patients and they have comparable accuracy and time efficient compared to conventional impression.

1. Introduction

Impressions have been used in the dentistry since the latter part of the eighteenth century, and is of great importance in the practice of dentistry. Throughout the past two centuries, the methods of making dental impressions have greatly evolved. The 20th century showed remarkable advances in technology, and digital impressions for use in dentistry came about in the 1980's. In the decades following, digital impression techniques have continued evolving and their uses have broadened. Interest in three-dimensional imaging and digital scanning has increased recently. Digital impressions and 3D models have a wide range of application in the dental field and dental specialties.[1]

Orthodontists use various dental records such as dental models or casts for diagnosis and treatment planning which includes making of dental impressions and pouring study casts.[2] Conventional alginate impression techniques are challenging for the patients with extreme gag reflex, irritation & discomfort.[2] It requires stocking of raw

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https://doi.org/10.18231/j.ijodr.2023.033

materials as well as storage space for the plaster models.[3] Plaster models are subject to loss, fracture, and degradation.[4] Current interest in 3D technology has led to development of scanning and digital models. Digital casts has numerous advantages such as more efficient storage, data retrieval, transferability, decreased processing time. In 1999, digital models were first made accessible in orthodontics. These models were made by scanning plaster casts made from impressions.[5] Diagnostic measurements have usually been made on plaster dental casts. 3D digital dental models can be used now.[6] Digital models can be used in orthodontics for analysis of teeth and occlusion, treatment simulation, appliance design and production, and assess the treatment effects.[1] No significant differences were found in the assessments of linear interarch, overjet, overbite, and arch-length measurements obtained from these digital 3D models and their corresponding plaster models on comparison.[7] The most critical requirement for a digital model system in orthodontics is its diagnostic precision.[8]

With the development of digital impression and their reported advantages, one major concern has been the accuracy. Since the introduction of 3-dimensional scanning in dentistry, a number of dental and orthodontic providers have started making digital scanners and thorough software analysis programmes that perform a wide range of tasks.[9] These functions simplify procedures such as dental analysis and diagnosis, occlusal setups, and treatment predictions. The digital software also offers new procedures, such as the ability to overlay models at different time points, allowing visualization of tooth movements and treatment outcomes.

Various manufacturing companies have been producing intraoral scanners. Each scanning system is advantageous to practitioners in one or the other way, including size of wand, use of powder, scanning method, ability to capture colour and record full mouth scan, ease of using software, device portability, time required for scanning and compactness of scanner.[9,10]

The intraoral scanners differ in method of image acquisition, as well as in unit size, speed and weight. Image acquisition techniques such as triangulation, active wavefront sampling (AWS), parallel confocal system, accordion fringe interferometry (AFI), three-dimensional in-motion video, telecentric system and IOS fast scan have been introduced. Examples of currently marketed intraoral scanning systems include the iTero Element (Align Technology, San Jose, CA), TRIOS 3 (3Shape A/S, Copenhagen, Denmark), True Definition (3M ESPE, St. Paul, MN), Cerec AC OmniCam (Sirona Dental Systems, Bensheim, Germany), CS3600 (Carestream Health, Rochester, NY), and PlanScan (Planmeca/E4D Technologies, Richardson, TX) and Medit.[11]

In this study Medit i500 scanner is used for digital impression technique. To acquire 3D images triangulation technology is used. The operator can move the scanner in a way that minimises patient discomfort. It functions with the Medit Link programme. The scanning is powder free which is more comfortable for the patients. The Medit link application saves the scan in various formats like OBJ, STL or PLY so it can be used with the software that supports these formats.

Conventional methods of impression taking uses impression materials which are dimensionally stable such as alginate or agar. Zhermack neocolloid Alginate is used for this study which has high thixotropy, accuracy in the reproduction of details and a dimensional stability from 48 to 120 hours. It has become essential for assessing the reliability of tooth size-arch length discrepancy measurements performed on digital impressions and compare the measurements with those obtained from plaster models by means of traditional methods. So a comparison between the digital and conventional method is done in this study.

Patient acceptance was checked using a questionnaire. Various types of surveys can be utilized for psychometric measurements, and the most commonly used measurement scales are the Likert scale and visual analog scale (VAS), both of which have been found to be reliable. The Likert scale provides multiple pre-determined categories for the subject to select, such as "strongly agree, agree, neutral, disagree, and strongly disagree." It is measured with ordinal numbers, where each answer choice is assigned a nominal value.[12] Improvement of patients' satisfaction can result in increase in patient compliance. This is especially true in patients who may have fear or anxiety related to healthcare. Due to the limited data and controversial findings from studies examining patients' opinions of intraoral scans, more information is needed to evaluate patient satisfaction and preference for different impression types. So this study was done to compare the accuracy, time and patient acceptance between intraoral scanner and conventional alginate impression technique.

2. Materials and Methods

2.1. Instruments and materials that will be used

1. Equipment
   (a) Medit i500 intraoral scanner(Medit Corp., Seoul, Korea).
   (b) Digital vernier caliper (Oleander).
   (c) Stopwatch
2. Materials
   (a) Alginate impression material (Neocolloid Zhermack, Badia Polesine, Italy)
   (b) Dental stone (Orthokal, Kalabhai Karson Pvt. Ltd., India)
   (c) Rubber bowl
   (d) Alginate mixing spatula

(e) Impression trays

2.2. Method

2.2.1. Inclusion criteria

1. Patients with age range between 15-50 years.
2. Patients with full complement of permanent teeth from first molar to contralateral first molar in both the jaws.
3. No missing or heavily restored teeth.
4. No remaining deciduous teeth, no supernumerary teeth.
5. No teeth with large carious lesions or enamel defects. that would affect the mesiodistal morphology of crown.

2.2.2. Exclusion criteria

1. Patients with history of mental, emotional or developmental disabilities, cleft lip or palate or other craniofacial anomalies, epilepsy, seizures or chronic use of anticonvulsants.
2. Patient with missing and heavily restored teeth
3. Patients with deciduous teeth and supernumerary teeth
4. Patients with large carious lesions and enamel defects which affects the mesiodistal morphology of crown.

2.2.3. Procedure

The patients were selected based on the inclusion and exclusion criteria. Informed consent was obtained. All patients underwent oral prophylaxis.

Two procedures were done on each patient as follows:

1. Conventional alginate impression (Neocolloid Zhermack, Badia Polesine, Italy).
2. Digital impression with intraoral scanner (Medit i500, Medit Corp., Seoul, Korea).

All the materials needed to perform the procedures was organized before seating the patient (Figures 1 and 2). Upper and lower alginate impression (Figure 3) were made with neocolloid impression material (Neocolloid Zhermack, Badia Polesine, Italy).

The impressions were poured in dental stone (Orthokal, Kalabhai Karson Pvt Ltd., India) to obtain study models (Figures 4 and 6). Base pouring was done with dental plaster.

The intraoral scan was performed with Medit i500 intraoral scanner (Medit Corp., Seoul, Korea). Full arch scanning was done (Figure 7). The second and third molar were included in the scan, when present. The scan was opened in Medit link software and digital image was obtained (Figure 8). Timing was recorded for both the procedures. While taking the alginate impression time was recorded from tray selection till impression removal. After the clinical procedure, each patient was asked to complete the specifically designed survey. For the first method of measurement (Figure 5), a digital vernier caliper (Oleander) was used to record tooth widths from the stone models (Orthokal, Kalabhai Karson Pvt Ltd., India). The second method of measurement involves using tools in Medit link software (Figure 8). Tooth widths were measured by selecting maximum mesiodistal diameter of each crown. An anterior and an overall Bolton ratio was calculated. In this study, validity is considered to be the extent to which the measurements from digital system agreed with the caliper measurements. Measurements made with caliper are taken to be the true values. Accuracy was judged as the closeness of the digital values to the caliper measurements which was assessed by measuring anterior and overall Bolton ratio.

Fig. 1: Alginate impression material (Neocolloid Zhermack, Badia Polesine, Italy)

Fig. 2: Materials required for impression

Fig. 3: Upper and lower alginate impressions (Neocolloid Zhermack, Badia Polesine, Italy)

Fig. 4: Type III dental stone (Orthokal, Kalabhai Karson Pvt. Ltd,) India)

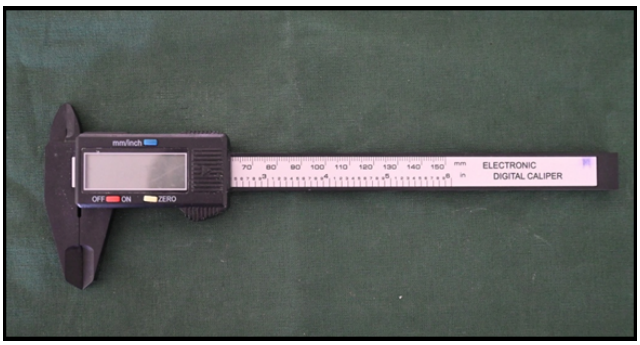

Fig. 5: Digital vernier caliper (Oleander)

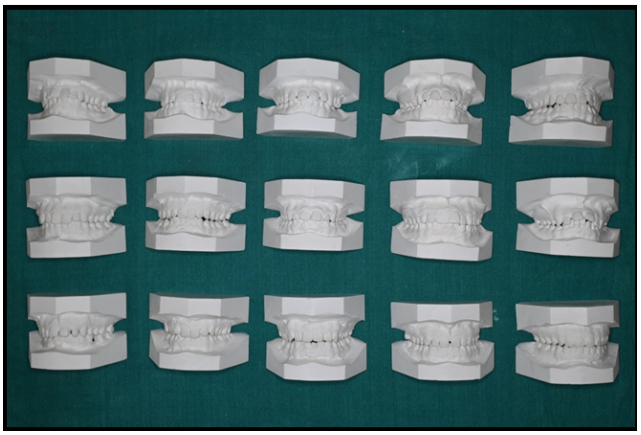

Fig. 6: Study models

Fig. 7: Medit i500 intraoral scanner (Medit Corp., Seoul, Korea)

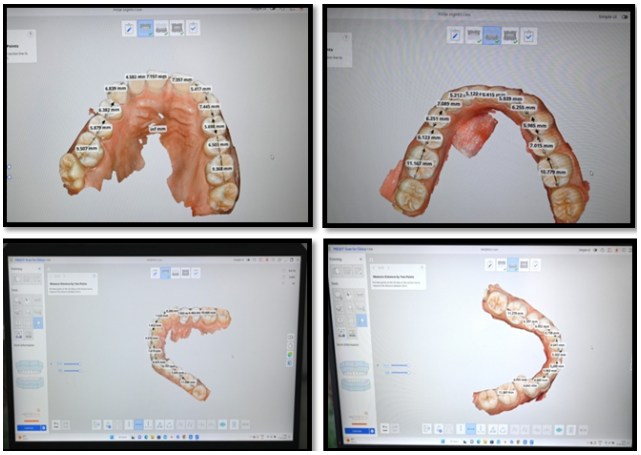

Fig. 8: Intraoral scan images with tooth width measurements

3. Results

Data was entered into Microsoft Excel spreadsheet and was checked for any discrepancies. Summarized data was presented using Tables and Graphs. The data was analysed by SPSS (21.0 version). Shapiro Wilk test was used to check which all variables were following normal distribution. Data was normally distributed therefore, bivariate analyses were performed using the parametric tests i.e Independent t test. For finding the association between categorical variables, Chi square test was used. Level of statistical significance

was set at p-value less than 0.05.

As per the results obtained, the mean value for ABR was found to be 78.63 and 78.78 for alginate and digital impression respectively which is not statistically significant (p=0.89;Table 1). The mean for OBR was 93.65 and 93.72 for alginate and digital impression, which is again statistically not significant (p=0.94; Table 1). The result shows no significant difference between the Bolton ratio calculated by both the methods as p>0.05.

Work time analysis for the digital and the conventional impression procedures revealed a significantly reduced mean chair time for the digital workflow of 3.39 min compared with the conventional approach with 7.46 min (p=0.001; Table 2). In Tables 3, 4, 5, 6, 7 and 8, the calculated mean results are presented related to treatment time, patients' comfort level, anxiety, gag reflex, queasiness, ease of breathe and possible stress during impression procedures. In general, significant differences [P < 0.05] were evident for all six questions' pairings, always favouring the digital technique over the conventional approach (Tables 3, 4, 5, 6, 7 and 8). One additional question regarding overall perception was given. Again, analysis demonstrated mean satisfaction scores with a trend favoring the digital impression for the defined categories: with overall mean value of 25.53 (P =0.001).

No significant difference was seen in the Anterior and overall Bolton ratio of the impression taken from digital scanning or alginate impression as p>0.05.

Time taken was found to be significantly more when impression was taken from alginate impression technique as p<0.05.Table 2

Significant difference was seen in the perception of gag reflex when subjects were asked between alginate impression or digital scanning. More number of subjects among whom digital scanning was done said that they did not feel gag reflex.Table 3

Significant difference was seen in the perception of queasiness when subjects were asked between alginate impression or digital scanning. More number of subjects among whom digital scanning was done said that they did not feel queasiness. Table 4

Significant difference was seen in the perception regarding easy breathe when subjects were asked between alginate impression or digital scanning. More number of subjects among whom digital scanning was done said that they had easy breathe.Table 5

Significant difference was seen in the perception regarding comfort feeling when subjects were asked between alginate impression or digital scanning. More number of subjects among whom digital scanning was done said that they felt comfortable.Table 6

Significant difference was seen in the perception regarding appointment for the impression when subjects were asked between alginate impression or digital scanning. More number of subjects among whom digital scanning was done said that their appointment for the impression did not last long.Table 7

Significant difference was seen in the perception regarding stress for the appointment when subjects were asked between alginate impression or digital scanning. More number of subjects among whom digital scanning was done said that they had no stress.Table 8

Overall perception score was found to be significantly more in digital scanning group favouring the digital impression.Table 9

4. Discussion

Analysis of tooth size differences is necessary for both orthodontic diagnosis and treatment planning. It has even been referred to as the seventh key of occlusion and is regarded as the important variable, particularly in the anterior segment. Bolton was the first to identify the precise ratios of the mesiodistal width that exist between the maxillary and the mandibular dentition from canine to canine and from first molar to first molar in order to achieve an ideal occlusion in 1958. Earlier authors such as Neff, Ballard, and Lundstrom had made attempts to quantify this relationship.[2]

According to Bolton the purpose of the tooth size discrepancy ratio as a diagnostic aid is "to gain insight into the function and esthetic outcome of a given case without the use of keslings diagnostic setup". Though Bolton's analysis is considered as the gold standard for predicting interarch tooth size discrepancies, this study aims in comparing the validity of the values between two methods namely vernier calipers and digital software measurements.[2]

In the present study 15 patients between 15-50 years of age were selected. One set of alginate impression was made. Digital models were obtained by using Medit i500 intraoral scanner (Medit Corp., Seoul, Korea) and the digital values were attained using medit link software (Figures 7 and 8). Linear measurements of each tooth (mesiodistal width) were calculated in the study models using digital vernier caliper (Oleander; Figure 5).

Caliper measurements were recognised as the gold standard to which other measuring methods were compared, according to Jennifer Asquith et al. Shellart et colleagues used vernier calipers and needle point dividers to calculate the Bolton's analysis values. To avoid a parallelex mistake, a digital vernier caliper was employed in place of a vernier caliper.[13] This study evaluated the validity of the Medit i500 intraoral scanner and its associated software in measuring mesiodistal widths and determining Bolton's ratios.

To compare the two groups, chi square test was used and P value was calculated to find the significance level. There was no statistically significant difference between the Bolton ratios from the digital method and the caliper

Table 1: Intergroup comparison of Anterior and overall Bolton ratio

		N	Mean	Std. Deviation	Std. Error Mean	P value
Anterior Bolton ratio (ABR)	Alginate impression	15	78.6300	3.02560	.78121	0.897
	Digital scanning	15	78.7847	3.44411	.88927	
Overall Bolton ratio (OBR)	Alginate impression	15	93.6547	2.54449	.65698	0.947
	Digital scanning	15	93.7273	2.70937	.69956	

Table 2: Intergroup comparison of time taken

		N	Mean	Std. Deviation	Std. Error Mean
Time taken	Alginate impression	15	7:46:40.00	0:15:20.528	0:03:57.679
	Digital scanning	15	3:39:36.00	0:45:19.435	0:11:42.155
P value					0.001

Table 3: Perception regarding gag reflex

			q1					Total
			Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Group	Alginate impression	N	3	9	1	1	1	15
		%	20.0%	60.0%	6.7%	6.7%	6.7%	100.0%
	Digital scanning	N	0	0	0	9	6	15
		%	0.0%	0.0%	0.0%	60.0%	40.0%	100.0%
Total		N	3	9	1	10	7	30
		%	10.0%	30.0%	3.3%	33.3%	23.3%	100.0%
P value								0.001

Table 4: Perception regarding Queasiness

			q2					Total
			Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Group	Alginate impression	N	1	4	8	1	1	15
		%	6.7%	26.7%	53.3%	6.7%	6.7%	100.0%
	Digital scanning	N	0	0	1	8	6	15
		%	0.0%	0.0%	6.7%	53.3%	40.0%	100.0%
Total		N	1	4	9	9	7	30
		%	3.3%	13.3%	30.0%	30.0%	23.3%	100.0%
P value								0.001

Table 5: Perception regarding easy breathe

			q3				Total
			Disagree	Neutral	Agree	Strongly agree	
Group	Alginate impression	N	4	7	3	1	15
		%	26.7%	46.7%	20.0%	6.7%	100.0%
	Digital scanning	N	0	1	7	7	15
		%	0.0%	6.7%	46.7%	46.7%	100.0%
Total		N	4	8	10	8	30
		%	13.3%	26.7%	33.3%	26.7%	100.0%
P value							0.002

Table 6: Perception regarding comfort feeling

			q4					Total
			Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Group	Alginate impression	N	2	3	8	1	1	15
		%	13.3%	20.0%	53.3%	6.7%	6.7%	100.0%
	Digital scanning	N	0	0	4	6	5	15
		%	0.0%	0.0%	26.7%	40.0%	33.3%	100.0%
Total		N	2	3	12	7	6	30
		%	6.7%	10.0%	40.0%	23.3%	20.0%	100.0%
P value								0.014

Table 7: Perception regarding appointment for the impression

			q5				Total
			Disagree	Neutral	Agree	Strongly agree	
Group	Alginate impression	N	3	6	3	3	15
		%	20.0%	40.0%	20.0%	20.0%	100.0%
	Digital scanning	N	0	2	9	4	15
		%	0.0%	13.3%	60.0%	26.7%	100.0%
Total		N	3	8	12	7	30
		%	10.0%	26.7%	40.0%	23.3%	100.0%
P value							0.043

Table 8: Perception regarding stress for the appointment

			q6					Total
			Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
Group	Alginate impression	N	1	7	1	3	3	15
		%	6.7%	46.7%	6.7%	20.0%	20.0%	100.0%
	Digital scanning	N	0	1	0	9	5	15
		%	0.0%	6.7%	0.0%	60.0%	33.3%	100.0%
Total		N	1	8	1	12	8	30
		%	3.3%	26.7%	3.3%	40.0%	26.7%	100.0%
P value								0.040

Table 9: Intergroup comparison of overall perception

	N	Mean	Std. Deviation	Std. Error Mean
Alginate impression	15	17.2000	5.22631	1.34943
Digital scanning	15	25.5333	2.94877	.76137
P value				0.001

measurements obtained from alginate group. The tooth widths obtained from the alginate impression showed slightly increased values in comparison with the medit link software values (Table 1).

Dental cast analysis plays a vital role in clinical orthodontic practice for both diagnosis as well as for predicting and assessment of the treatment outcome. According to the literature review there are no universal standard for defining the accuracy of a study model.[7]

Orthodontists are now exposed to new tools as a result of technological advancements, which aid in more precise diagnosis and treatment planning. The diagnostic information from plaster models that are converted to digital files is very accurate. The digital models obtained from that intraoral scanner eliminate the inherent problem of model storage. They also have potential benefits such as: Instant accessibility of 3D information without need for retrieval of plaster model from storage area, ability to perform accurate treatment planning and diagnostic set ups for various orthodontic cases, virtual images can be transferred anywhere in the world for referral and consultations.[7]

The present study compared the validity of intraoral dental scanner; impression material retrieved study models. The result of this study showed that the tooth width

replication by both methods showed a reliable value (Table 1). In a study by Ursus R Schimer et al they evaluated the accuracy and reliability of computer aided space analysis. They compared 3D orthodontic dental casts with photocopies of stone models and found that dental casts cannot be accurately reproduced on photocopies hence accurate space analysis from photocopies is not possible.[14] In another study done by Kazuo Hayashi et al they studied the accuracy and reliability of Sure Smile Ora Scanner with Vivid910 Scanner and R700 scanner. They found all these scanners are sufficiently accurate when compared with gold standard and there was no significant difference in the reliability between all these comparisons.[15]

The study also included investigating patients' perceptions regarding the scanner, and relative chairside time requirements for different impression methods. Limited studies evaluating the use and patient perception of intraoral scanners in the orthodontic field have also been completed, with differing results.[2,16,17] Vasudevan et al found that 77% of patients preferred intraoral scans over alginate impressions. Grünheid et al found that 73.3% of patients preferred alginate impressions over intraoral scans. Burhardt et al found that young patients preferred digital impression techniques over alginate impressions. The studies listed above used scanners that required teeth to be coated with a layer of titanium dioxide powder. Burhardt's study investigated the impact of the titanium dioxide powder and found that over 60-70% of subjects reported noticing the powder.[9] The scanners used in the present study do not use titanium dioxide powder, and patients were comfortable during scanning procedure without any gag reflex (Tables 3 and 6) and they did not feel stressed (Table 8).

All patients answered a comparative questionnaire between the two techniques. The results showed that digital impressions are more efficient than conventional impression, and have been preferred by 100% of the patients in this study (Table 9). Therefore, the study concludes that the total treatment time during the conventional impression technique is longer when compared to the digital system (Table 2). The results are in accordance with the study done by Maria Francesca Sfondrini et al.[18] Digital impressions used for prosthodontic and restorative means have been studied, and recent data suggest that patients prefer digital impressions to conventional polyether techniques.[17]

In a study by Ulf Schepke et al the digital impression proved to be a more efficient technique when the total time of treatment was evaluated; the digital system required fewer reps, which helped reduce the final treatment time; the difficulty of the technique was less for digital than conventional impression when performed by inexperienced operators.[17] This is in accordance with the present study.

According to study by Thorsten Grunheid et al (2014) despite the high accuracy of chairside oral scanners, alginate impressions were still the preferred model acquisition method with respect to chair time and patient acceptance.[2] This was contradictory as we found that digital impressions are less timing consuming with comparable accuracy and are accepted by patients compared to conventional impression technique (Tables 2 and 9).

5. Limitations

While the study revealed some significant differences in patient satisfaction regarding digital and alginate impressions, the limitations of this study should be recognized. As mentioned above, the lack of even distribution for age and previous impression experience among groups are confounding variables that could affect the subjects' responses. Finally, as with all research involving surveys and questionnaires, the inherent issue of response bias is present.

Further studies should analyze whether or not there could be age-related differences among patients' perceptions. Further studies with wider sample and comparing different age groups should be performed in order to deeply investigate those aspects. The method described to check accuracy in this study is time-consuming and requires training, and may give rise to operator related errors.

6. Scope for the Study

1. Additional research would be needed to confirm above findings and to determine the perception considering the age groups.
2. Further research with large number of samples can be done to obtain more accuracy.
3. Other methods to check accuracy can be used which consumes less time.
4. Comparison can be done by including more number of intraoral scanners.

7. Conclusion

Within the limits of the present investigation, the following conclusions can be drawn:

1. No significant difference was seen in the Anterior and overall Bolton ratio of the impression taken from digital scanning or alginate impression. Digital impressions are accurate and comparable to conventional impressions.
2. Digital impressions resulted to be faster than alginate impressions.
3. The overall patients' acceptance of digital impression techniques was significantly higher than that of conventional impression techniques. Medit i500 intraoral scanner scored a better value in terms of comfort, gag reflex breathing difficulty and stress for appointment.

8. Conflicting of Interests

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

9. Source of Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

References

1. Kusnoto B, Evans CA. Reliability of a 3D surface laser scanner for orthodontic applications. *Am J Orthod Dentofacial Orthop*. 2002;122(4):342–8. doi:10.1067/mod.2002.128219.
2. Grünheid T, Mccarthy SD, Larson BE. Clinical use of a direct chairside oral scanner: an assessment of accuracy, time, and patient acceptance. *Am J Orthod Dentofacial Orthop*. 2014;146(5):673–82. doi:10.1016/j.ajodo.2014.07.023.
3. Burzynski JA, Firestone AR, Beck FM, Fields HW, Deguchi T. Comparison of digital intraoral scanners and alginate impressions: Time and patient satisfaction. *Am J Orthod Dentofacial Orthop*. 2018;153(4):534–41. doi:10.1016/j.ajodo.2017.08.017.
4. Cuperus AM, Harms MC, Rangel FA, Bronkhorst EM, Schols JG, Breuning KH, et al. Dental models made with an intraoral scanner: a validation study. *Am J Orthod Dentofacial Orthop*. 2012;142(3):308–13. doi:10.1016/j.ajodo.2012.03.031.
5. Ko HC, Liu W, Hou D, Torkan S, Spiekerman C, Huang GJ, et al. Agreement of treatment recommendations based on digital vs plaster dental models. *Am J Orthod Dentofacial Orthop*. 2019;155(1):135–42. doi:10.1016/j.ajodo.2018.03.018.
6. Leifert MF, Leifert MM, Efstratiadis SS, Cangialosi TJ. Comparison of space analysis evaluations with digital models and plaster dental casts. *Am J Orthod Dentofacial Orthop*. 2009;136(1):16.e1–4. doi:10.1016/j.ajodo.2008.11.019.
7. Wiranto MG, Engelbrecht WP, Nolthenius HE, Van Der Meer W, Ren Y. Validity, reliability, and reproducibility of linear measurements on digital models obtained from intraoral and cone-beam computed tomography scans of alginate impressions. *Am J Orthod Dentofacial Orthop*. 2013;143(1):140–7. doi:10.1016/j.ajodo.2012.06.018.
8. Akyalcin S, Cozad BE, English JD, Colville CD, Laman S. Diagnostic accuracy of impression-free digital models. *Am J Orthod Dentofacial Orthop*. 2013;144(6):916–22. doi:10.1016/j.ajodo.2013.04.024.
9. Kravitz ND, Groth CH, Jones PE, Graham JW, Redmond WR. Intraoral digital scanners. *J Clin Orthod*. 2014;48(6):337–47.
10. Burgess JO, Lawson NC, Robles A. Comparing digital and conventional impressions: assessing the accuracy, efficiency, and value of today's systems. *J inside Dent*. 2013;9(11). Available from: https://www.aegisdentalnetwork.com/id/2013/11/comparing-digital-and-conventional-impression-materials.
11. Hack GD, Patzelt SB. Evaluation of the accuracy of six intraoral scanning devices: an in-vitro investigation. *ADA Prof Prod Rev*. 2015;10(4):1–5.
12. Hasson D, Arnetz BB. Validation and findings comparing VAS vs. Likert scales for psychosocial measurements. *Int Electron J Health Educ*. 2005;8:178–92.
13. Asquith J, Gillgrass T, Mossey P. Three-dimensional imaging of orthodontic models: a pilot study. *Eur J Orthod*. 2007;29(5):517–22. doi:10.1093/ejo/cjm044.
14. Schirmer UR, Wiltshire WA. Manual and computer-aided space analysis: a comparative study. *Am J Orthod Dentofacial Orthop*. 1997;112(6):676–80.
15. Hayashi K, Sachdeva AU, Saitoh S, Lee SP, Kubota T, Mizoguchi I, et al. Assessment of the accuracy and reliability of new 3-dimensional scanning devices. *Am J Orthod Dentofacial Orthop*. 2013;144(4):619–25. doi:10.1016/j.ajodo.2013.04.021.
16. Burhardt L, Livas C, Kerdijk W, Van Der Meer W, Ren Y. Treatment comfort, time perception, and preference for conventional and digital impression techniques: A comparative study in young patients. *Am J Orthod Dentofacial Orthop*. 2016;150(2):261–7.
17. Schepke U, Meijer HJ, Kerdijk W, Cune MS. Digital versus analog complete-arch impressions for single-unit premolar implant crowns: Operating time and patient preference. *J Prosthetic Dent*. 2015;114(3):403–6.e1. doi:10.1016/j.prosdent.2015.04.003.
18. Sfondrini MF, Gandini P, Malfatto M, Corato FD, Trovati F, Scribante A, et al. *Biomed Res Int*. 2018;p. 4103232. doi:10.1155/2018/4103232.

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Cite this article: Jajee M, Patil VS, Patil BC, Halkai SR, Kadammanavar J, Fatima M. Comparative evaluation of accuracy, time and patient acceptance between intraoral scanner and conventional alginate impression technique – An invivo study. *IP Indian J Orthod Dentofacial Res* 2023;9(3):183-191.