In Pursuit of Precision: Digital vs. Conventional Impressions in Pediatric Dentistry

[1] Yash Bafna; [2] Shrusti Shah; [3] Shobha Fernandes
[1] Professor, [2] PG Student, [3] HOD & Professor
[1,2,3] Department of Pediatric and Preventive Dentistry, Narsinhbhai Patel Dental College and Hospital, Visnagar, Sankalchand Patel University, Gujarat, India

Abstract

Background: Pediatric dental impressions play a vital role in diagnosis and treatment planning. Choosing between conventional and digital impression techniques can significantly influence clinical outcomes and patient experience. This study compares the accuracy, efficiency, and comfort of alginate and digital impression methods in pediatric patients. **Aim:** To compare the accuracy and efficiency of alginate and digital impression techniques in pediatric patients. **Materials and Method:** This randomized clinical trial included 50 children aged 3 to 10 years, divided into Group I (Primary Dentition, 3–6 years) and Group II (Mixed Dentition, 7–10 years). Participants were randomly assigned to receive either digital or conventional impressions first using the Random Number Table method. Key outcomes included dimensional accuracy (measuring canine-molar length, inter-canine width, and inter-molar width). Secondary outcomes assessed patient comfort, gag reflex, and impression time using the Visual Analog Scale (VAS). **Results:** In Primary Dentition, digital impressions showed smaller mean differences in dimensional measurements compared to conventional methods. In Mixed Dentition, the scanner showed slightly higher mean values. Digital impressions required less time and caused significantly less gag reflex. Children reported greater comfort with intraoral scanning, with results statistically significant. **Conclusion:** Digital intraoral scanning in pediatric dentistry offers superior speed, dimensional accuracy, and patient comfort compared to traditional alginate impressions. Its integration into clinical practice enhances diagnostic precision and patient experience, presenting a valuable tool for modern pediatric dental care.

Keywords: Digital intraoral impression, Conventional impression, Alginate, Pediatric dentistry

Introduction

In pediatric dentistry, where accuracy in diagnosis and treatment planning are crucial, accurate impressions of the oral cavity are essential to provide quality dental care. Alginate is the material of choice for diagnostic models because of its low cost, simplicity of use, and reliable performance.[1] Pediatric patients, however, have particular difficulties, including anxiety, gag reflexes, poor cooperation, and the requirement for quick handling to avoid impression distortion. These difficulties highlight the significance of improving impression techniques since they may have an impact on the patient's overall experience and the quality of the impression.[2]

By providing a state-of-the-art substitute for conventional techniques, digital impression systems that make use of Intraoral Scanners (IOSs) have revolutionized dental workflows. Without the use of conventional impression trays, alginate materials, or instantaneous model pouring, these scanners produce incredibly precise, three-dimensional images of the oral cavity. Digital impressions offer major benefits in pediatric settings as they expedite processes and minimize patient discomfort. The quicker and less intrusive method of digital scanning is advantageous for children, who frequently have dental anxiety. Additionally, digital impressions improve comfort and cooperation by elimination of the gag reflex that is frequently elicited by large trays and alginate materials.[3]

Digital impression systems have numerous advantages, but they also have drawbacks that may prevent their wider use in pediatric dentistry. For many practices, the high expenses of buying and maintaining IOSs can be a major deterrent. Furthermore, there is a learning curve associated with the technology that could initially cause procedure times to increase. The integration of digital workflows may be limited in certain contexts due to differences in access to sophisticated digital equipment based on geographic location or practice size.[4]

The choice of impression techniques is made more difficult by the particular requirements of pediatric dentistry. Due to their smaller mouths and differing degrees of cooperation, children require procedures that are both effective and low-stress. A quick and comfortable technique can have a significant impact on the procedure's success and the child's and parents' satisfaction.[4] For younger patients, digital impressions provide a clear benefit by cutting down on chair time and streamlining the procedure. However, because of its affordability and ease of use, alginate is still a viable choice, especially in settings without access to digital equipment.[5]

Digital impressions improve comfort and trust in pediatric care, while alginate remains reliable. Technology is reshaping how we meet children’s dental needs. Adopting new dental technology will be crucial to providing younger populations with high-quality,

patient-centered care.[6] So the aim of this study was to compare the accuracy and efficiency of both alginate and digital impression techniques in pediatric patients.

Materials and Method

Study design:

The present cross sectional RCT compared traditional alginate and digital intraoral scanning among patients between the ages of 3 to 10. The two participant groups were- Group I (Primary Dentition, ages 3 to 6) and Group II (Mixed Dentition, ages 7 to 10). The inclusion criteria were carefully defined, required participants to have fully erupted, caries-free, unrestored primary first molars without anomalies in order to assessment impressions. To maintain study precision, children with malocclusion, teeth with mobility, actively erupting teeth, or special healthcare needs were not included.

Study duration

This study spans a period of six months

Sample size determination and randomization

Adapting convenience sampling, 25 children in the age group of 3-10 years irrespective of race, gender, and socioeconomic status were selected for the study. A sample size of 50 achieves 99% power with a significance level (alpha) of 0.05. The Random Number Table method was used for randomization, to reduce selection bias. (Figure 1)

Parameters assessed

The study focused on important parameters like the inter canine width, inter molar width, and canine molar length and assessed the accuracy of dimension measurements using two distinct approaches. The amount of time spent creating impressions, expressed in stopwatch seconds, was one of the secondary evaluation criteria. Post session, VAS was used to measure the gag reflex and patient comfort. (Figure 2&3)

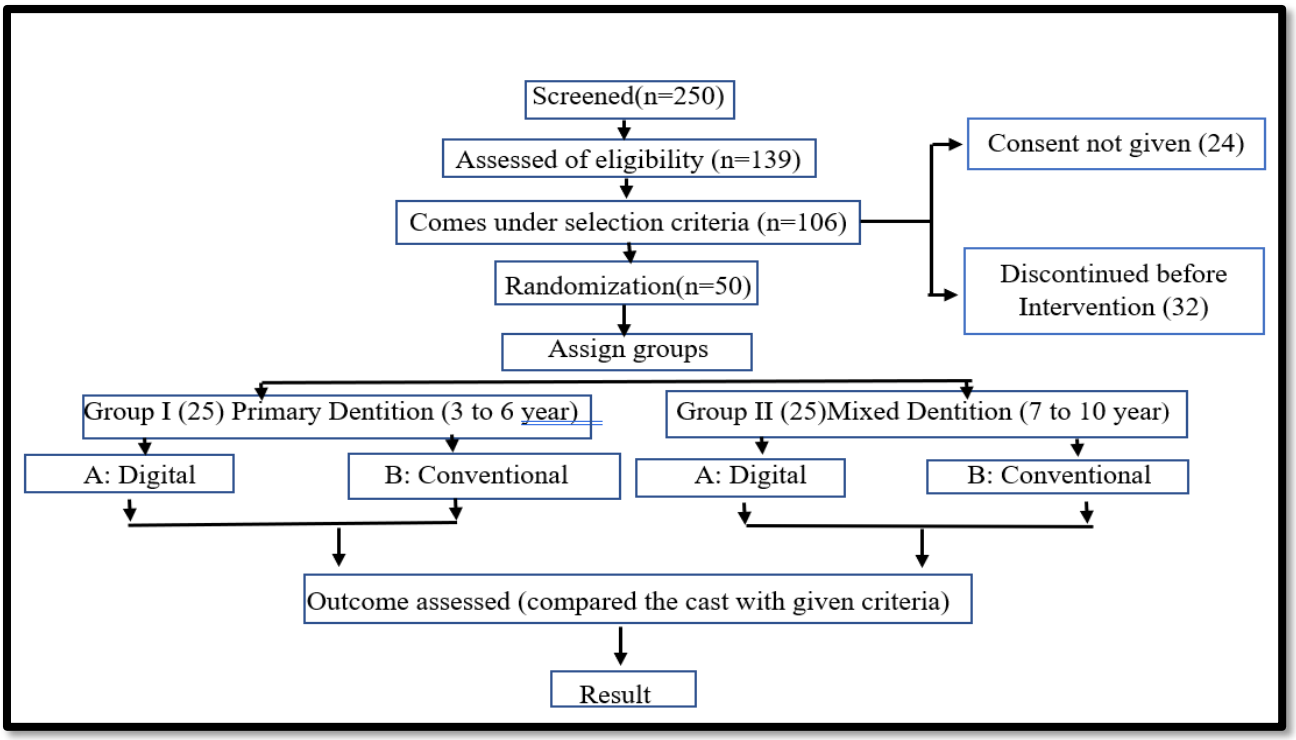


Figure 1 CONSORT diagram

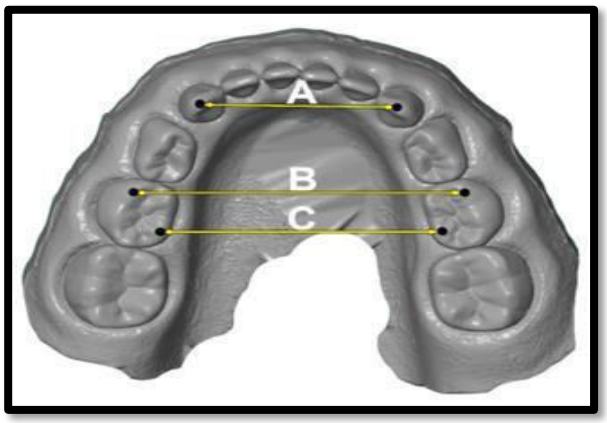


Figure-2. Intercanine Width- A,
Intermolar Width- B

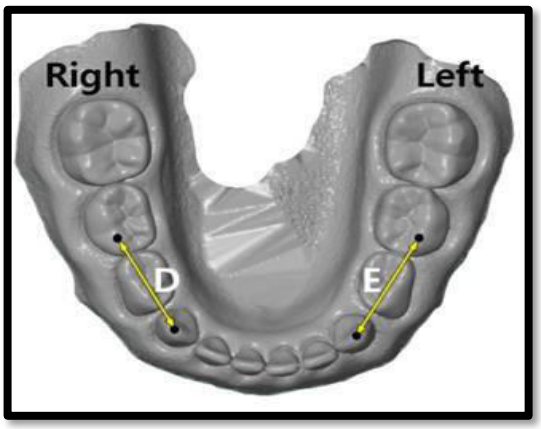


Figure-3. Caninemolar Linear-D,E

Data collection and analysis

A Microsoft Excel spreadsheet (Microsoft Office 2019; Redmond, WA: Microsoft Corp.) was used for data entry, and any inconsistencies were reviewed. The Shapiro-Wilk test was conducted to determine whether each variable followed a normal distribution. Statistical analysis, including descriptive statistics and inferential tests, was performed to compare the outcomes of the two impression techniques. Data analysis was conducted using SPSS software version 20.0 (Chicago, IL: IBM Corp.), with parametric tests such as Pearson's test and the paired t-test applied for vicariate analysis at a 5% significance level.

Result

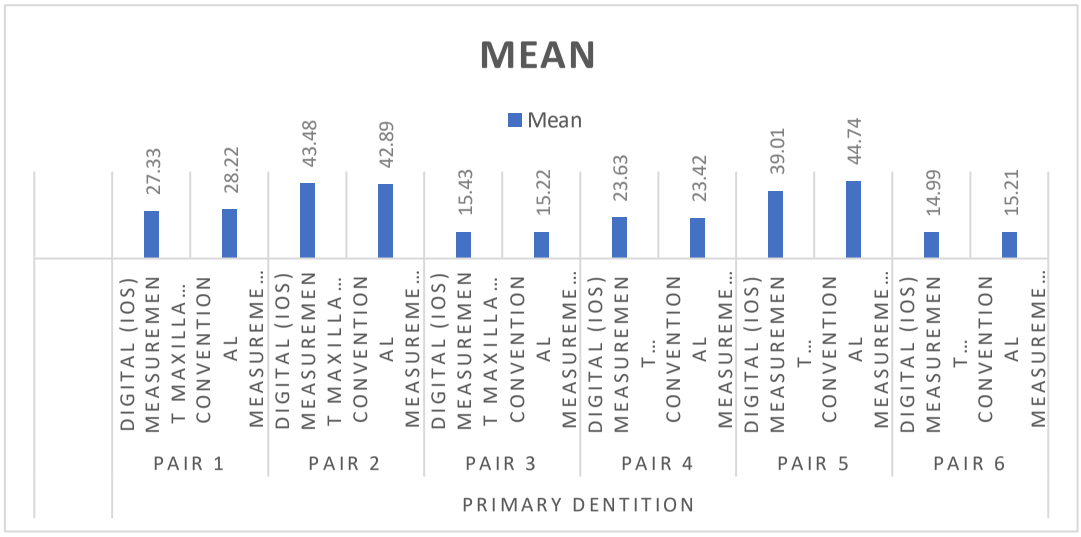
In both primary and mixed dentition, the intraoral scanner showed a significant difference compared to the conventional method. Hence, the results indicated that both impression techniques provide comparable inter-canine, inter-molar, and canine-molar width measurements, as shown below in (Table 1 & Graph 1&2).

Table 1: Primary & Mixed Dentition Intra group comparison of Inter-canine, Inter-Molar, Canine-Molar width between alginate and scanner group

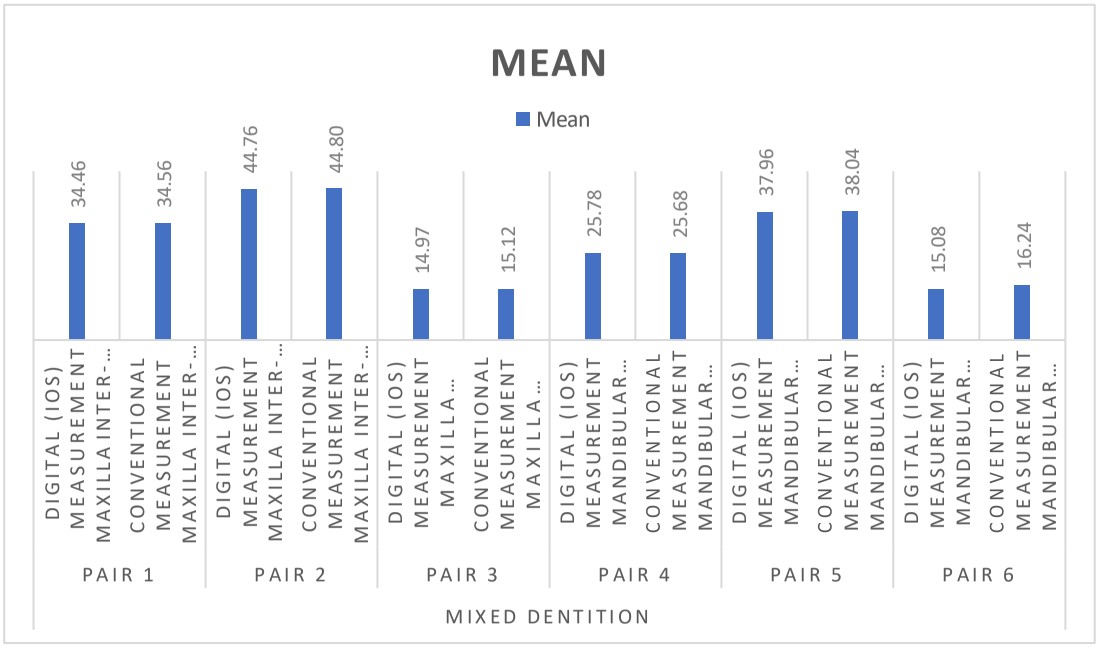
		Primary Dentition			**Mixed Dentition**		
Sr. no.	Parameter	Mean ± SD	Mean difference ± SD	p VALUE	Mean ± SD	Mean difference ± SD	P VALUE
	Maxilla Measurement						
1	Digital Measurement Inter-canine	27.33±0.62	-(0.89±0.87)	**<0.001**	34.46±1.48	-(0.1±0.1)	**<0.001**
	Conventional Measurement Inter-canine	28.22±0.88			34.56±1.58		
2	Digital Measurement Inter-Molar	43.48±0.73	0.59±0.54	**<0.001**	44.76±1.68	-(0.04±0.17)	0.24
	Conventional Measureme	42.89±0.47			44.8±1.61		

	nt Inter-Molar						
3	Digital Measurement Canine-Molar	15.43±0.77	0.21±0.74	0.241	14.97±0.36	-(0.15±0.43)	0.09
	Conventional Measurement Canine-Molar	15.22±1.26			15.12±0.6		
	Mandibular Measurement						
4	Digital) Measurement Inter-canine	23.63±0.76	0.21±0.77	0.263	25.78±1.2	0.1±0.08	**≤0.001**
	Conventional Measurement Inter-canine	23.42±1.02			25.68±1.25		
5	Digital) Measurement Inter-Molar	39.01±1.08	-(5.73±17.02)	0.159	37.96±3.52	-(0.08±0.1)	**0.001**
	Conventional Measurement Inter-Molar	44.74±17.06			38.04±3.47		
6	Digital Measurement Canine-Molar	14.99±0.32	-(0.22±0.46)	0.05	15.08±0.27	-(1.16±0.52)	**≤0.001**
	Conventional Measurement Canine-Molar	15.21±0.54			16.24±0.44		

Analysis revealed notable variations in impression methods. Compared to digital intraoral scanning, traditional alginate impressions were more uncomfortable, had a longer scanning time, and gag reflex. The gag reflex was stronger in the alginate group. Patients expressed more comfort with digital scanning at p<0.001, indicating that it was more comfortable option. (Figure 4 & 5)



Graph 1: Primary Dentition Intra group comparison between alginate and scanner group



Graph 2: Mixed Dentition Intra group comparison between alginate and scanner group

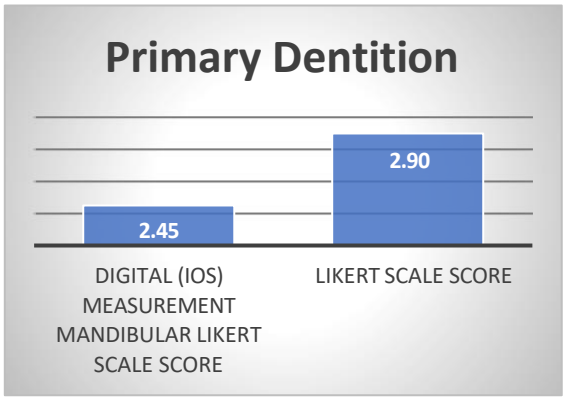


Figure-4 Evaluation of comfort with scanner & conventional impressions in Primary Dentition

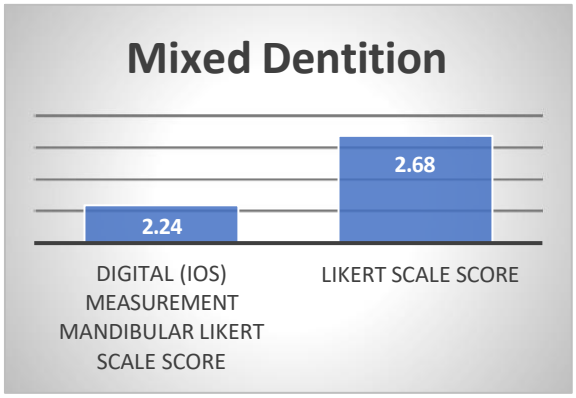


Figure-5 Evaluation of comfort with scanner & conventional impressions in Mixed Dentition

Discussion

Pediatric dentistry is often associated with patient anxiety, which can be influenced by the impression techniques employed. This study aimed to evaluate and compare the effectiveness of conventional alginate impressions and digital intraoral scanning in pediatric dental patients. The findings offer valuable insights into the relative performance of these techniques across several key parameters.[6,7]

In our study, we observed minimal differences in the measured parameters. Specifically, inter-canine width demonstrated a non-significant mean difference between the two evaluation techniques. However, intermolar width in the maxilla and the mesiodistal width of permanent central incisors showed statistically significant differences, with higher values recorded in the digital scanner group. Caliper measurements were used as the reference standard against which other methods were compared.[8]

Hayashi et al. evaluated the accuracy and reliability of several digital scanners, including the Sure Smile Ora Scanner, Vivid910 Scanner and R700 Scanner. Their findings indicated that all scanners were sufficiently accurate when compared to vernier calipers, with no significant differences in reliability[8]. Similar conclusions were drawn by Murugesan and Sivakumar.

A recent systematic review by Kong et al., observed conventional alginate impressions were more thorough representation of subtle anatomical features, even though neither method accurately reproduces intraoral structures. However, this study found that both methods were equally true. [9,10]

Time Efficiency

It is essential to comprehend the effects of impression-taking time in order to enhance treatment results, procedural effectiveness, and patient comfort. Studies by Burhardt et al. and Mangano et al.[11] found shorter times for alginate impressions, but Yilmaz and Aydin et al.[12] found no discernible differences in the overall impression time between the two approaches. On the other hand, when taking into account the entire duration of treatment, Schepke et al.,[13] discovered that digital impressions were more effective. Further cutting down on procedure time, digital systems also required fewer repetitions.[14]The results of this study are consistent with Asquith et al.'s observation that digital scanning presented fewer difficulties for novice operators than traditional methods. [15]

Patient Comfort

A statistically significant difference was observed in favor of the scanner group over the alginate group with respect to patient comfort and gag reflex. Alginate impressions are known to cause discomfort due to their odor, texture, and bulk, which may contribute to the induction of gag reflexes. Furthermore, factors such as ill-fitting trays, overextensions, and perceived pressure during the impression process can result in discomfort or pain—issues that are largely minimized with intraoral scanning.

It is noteworthy that only successful impressions were included in this study. This emphasizes the longer time required for alginate impressions, particularly in uncooperative patients, whereas digital scans were completed without the need for repetitions, contributing to enhanced patient comfort.

Digital scanning demonstrated a significant advantage in terms of patient comfort, particularly in reducing the gag reflex. The scanner group showed statistically significant improvements over the alginate group. Alginate impressions often cause discomfort due to factors like their odor, texture, bulk, and the subjective pressure exerted during the procedure. These factors, which can exacerbate the gag reflex, are largely absent with digital scanning.

Study Limitations

Intraoral scanners offer enhanced patient comfort, quicker procedures, and easy digital storage, but they are costly, technique-sensitive, and may have difficulty capturing subgingival margins or scanning in limited oral spaces. Alginate impressions are affordable and effective in capturing fine details, yet they often cause discomfort, can trigger gag reflexes, and are prone to dimensional changes if not poured immediately. Both methods rely on operator skill and patient cooperation for accuracy.

Conclusion

The conclusion of the study highlights the advantages of digital intraoral scanning in pediatric dentistry over conventional alginate impressions. By lowering gag reflexes, acquiring impressions faster, and attaining high dimensional accuracy, digital scanning enhanced patient comfort. These results demonstrate the revolutionary potential of digital technology in enhancing dental procedures, even though considerations like cost and the associated learning curve must be made.

References

1. Rolfsen CC, Fidel PL, Wen Z, Chapple A, Ahluwalia JP, DiVittorio A, et al. Direct comparison between intraoral scanning and alginate impressions for pediatric patients: an in vitro study. J Dent Child (Chic). 2023; 90(1):17–21.
2. Kumari S, Reddy DC, Paul ST. The normal range of maximal incisal opening in pediatric population and its association with physical variables. Ann Afr Med. 2019; 18(3):153–7.
3. 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 Prosthet Dent. 2015; 114(3):403–6.
4. Mangano A, Beretta M, Luongo G, Mangano C, Mangano F. Conventional vs digital impressions: acceptability, treatment comfort and stress among young orthodontic patients. Open Dent J. 2018; 12: 118–24.
5. Burzynski JA, Firestone AR, Beck FM, Fields HW Jr, Deguchi T. Comparison of digital intraoral scanners and alginate impressions: time and patient satisfaction. Am J Orthod Dentofacial Orthop. 2018; 153(4):534–41.
6. Weise C, Frank K, Wiechers C, Weise H, Reinert S, Koos B, et al. Intraoral scanning of neonates and infants with craniofacial disorders: feasibility, scanning duration, and clinical experience. Eur J Orthod. 2022; 44(3):279–86.
7. Singh I, Singh K, Sethi N. Digital impression in dentistry: a comprehensive review. Asian Pac J Health Sci. 2022; 9(10.21276).
8. Gupta R, Brizuela M. Dental impression materials.
9. Marinelli A, Mariotti M, Defraia E. Transverse dimensions of dental arches in subjects with Class II malocclusion in the early mixed dentition. Prog Orthod. 2011; 12(1):31–7.
10. Liczmanski K, Stamm T, Sauerland C, Blanck-Lubarsch M. Accuracy of intraoral scans in the mixed dentition: a prospective non-randomized comparative clinical trial. Head Face Med. 2020; 16(1):11.

11. Hayashi K, Sachdeva AU, Saitoh S, Lee SP, Kubota T, Mizoguchi I. Assessment of the accuracy and reliability of new 3-dimensional scanning devices. Am J Orthod Dentofacial Orthop. 2013; 144(4):619–25.
12. Murugesan A, Sivakumar A. Comparison of accuracy of mesiodistal tooth measurements made in conventional study models and digital models obtained from intraoral scan and desktop scan of study models. J Orthod. 2020; 47(2):149–55.
13. Kong L, Li Y, Liu Z. Digital versus conventional full-arch impressions in linear and 3D accuracy: a systematic review and meta-analysis of in vivo studies. Clin Oral Investig. 2022; 26(8):5625–42.
14. Tomita Y, Uechi J, Konno M, Sasamoto S, Iijima M, Mizoguchi I. Accuracy of digital models generated by conventional impression/plaster-model methods and intraoral scanning. Dent Mater J. 2018;37(4):628–33.
15. Yilmaz H, Aydin MN. Digital versus conventional impression method in children: comfort, preference and time. Int J Paediatr Dent. 2019; 29(6):728–35.