Received: 21 June 2019 | Revised: 15 July 2019 | Accepted: 22 July 2019

DOI: 10.1111/ipd.12566

ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF PAEDIATRIC DENTISTRY WILEY

Digital versus conventional impression method in children: Comfort, preference and time

Hakan Yilmaz[1] | **Merve Nur Aydin**[2]

[1]Department of Orthodontics, Faculty of Dentistry, Istanbul Okan University, Istanbul, Turkey

[2]Department of Pediatric Dentistry, Faculty of Dentistry, Istanbul Okan University, Istanbul, Turkey

Correspondence
Hakan Yilmaz, Department of Orthodontics, Faculty of Dentistry, Istanbul Okan University, Istanbul, Turkey.
Email: hakanyilmaz90@gmail.com

Background: The comfortness and effectiveness of digital and conventional impression methods in children have not yet been compared.

Aim: To assess the digital and conventional impression methods in children in terms of comfort, preference, and the time required to take impressions.

Design: Digital impressions were taken by using an intraoral scanner, and conventional impressions were taken by using alginate from 28 patients by the same operator. In each impression-taking-process, comfort was assessed by both the children and the clinician, and the chairside times were written. Student's *t* tests and Mann-Whitney *U* tests were used for statistical analyses, and $P < .05$ was considered to be significant.

Results: The digital impression was considered to be more comfortable in the assessments by both the children and the clinician ($P < .001$). The total time the digital impression took was 465.89 ± 76.71 second(s) while that of the conventional impression was 450.25 ± 64.08 s when the chairside times of the two impression methods were compared. There was no statistically significant difference ($P = .41$).

Conclusion: The digital impression method compared with the conventional impression method was found to be both more comfortable and preferable by the children, but there was no difference in terms of the time required to take impressions.

KEYWORDS
children, clinical efficiency, digital impression, patient comfort

1 | INTRODUCTION

Although the plaster models obtained using conventional impressions in dentistry are often used in diagnosis and treatment procedures, they have disadvantages such as their size, risk of loss or fracture, and difficulties during the fabrication of models.[1] Due to the advantages of digital impressions and intraoral scanning systems such as the ability to store captured information indefinitely, low storage space, rapid access to 3-dimensional (3D) records, and facilitating communication with professionals and patients,[2] the interest in these impression methods is increasing.[3] Also, digital impressions combined with CAD/CAM technology allow a completely digital workflow, starting from impression to framework planning, to realization of final work. This completely digital workflow has been demonstrated to be effective in various fields of dentistry, such as prosthodontics,[4] conservative dentistry,[5] and orthodontics.[6] The digital models, however, obtained through intraoral scans are not fully integrated into private practices that are as durable as conventional methods.[7] Moreover, today conventional impression methods are more readily accepted and inexpensive practices.[7,8]

Since the emergence of 3D systems, research has been conducted to compare accuracy and reliability, and it has been shown that precision of conventional and digital methods has similar or clinically insignificant differences.[9]

With the decreasing of suspicions about the accuracy in studies on digital and conventional impressions, the research on this issue has focused on the potential benefits to the patient and the clinician, and especially on the comfort and speed of the methods,[3,10-15] which is not surprising as clinicians and patients demand less time-consuming and more comfortable methods, with the development of dental practices.[14,16] Furthermore, the conventional impression methods have been reported by patients as disturbing[7,14,17] and even described to be the worst treatment stage they have ever experienced.[3] This is because patient comfort may often be disturbed by the stimulation of the gag reflex during the conventional impression methods,[11,18] whereas the digital impression methods have an important capacity to prevent the gag reflex.[14,15] Another factor affecting the patient and the clinician comfort concurrently during the taking of impressions is the time required to complete the process.[12,13] Grunfield et al[12] have stated that because impressions taken by alginate require shorter chairside time than those taken by intraoral scans, the conventional impression method is considered more preferable and comfortable by patients.

In orthodontics and paediatric dentistry, impressions are taken from children for diagnosis and treatment procedures (such as space maintainer, habit breaker fabrication, and so forth). Today, a digital change is visible in dentistry in the field of impression taking. This is because with the development of the systems in this field, a complete change can be expected in the impression-taking procedure, which is considered as the worst experience by patients and children.[19] In addition to that, the comfort of impression methods and the time they require are important because it is known that children are more stressed in their encounter with the dentist than the elderly, and their chairside times are shorter.[20] The comparison of impression methods in terms of comfort, preference, and time has been studied only in young adults or adult patients.[11-15,21] Although there are studies on adolescents[3,7,22] and young adolescents[23] who most commonly undergo orthodontic treatment, to the best of our knowledge, there are no studies investigating the comfort of children during the impression-taking procedure.

For this reason, the aim of this study was to compare in digital and conventional methods the impression-dependent factors (gag reflex, queasiness, smell/taste, heat/cold, and so forth) and the time required to take impressions, which affect patient and clinician comfort, in children (7-13 years old), and to contribute to children's adaptation to dental procedures. The first null hypothesis was that there were no significant differences between conventional and digital impression-taking methods in terms of comfort. The second null hypothesis was that there were no significant differences between the two methods in terms of the total time required for impression taking.

Why this paper is important to paediatric dentists

- For paediatric dentists, it is important to know which impression method is more comfortable as children often lose their comfort during the impression process.
- Using the knowledge of which impression method takes less time in busy dental practice can improve the comfort of the paediatric dentists.
- Intraoral scanner systems are constantly updated, modified and accelerated. Therefore systems that have been cumbersome in the past should be retested today. With this article, paediatric dentists will be able to access more up-to-date information about the effectiveness and comfort of impression methods.

2 | MATERIAL AND METHODS

A total of 30 children who were admitted to the Department of Paediatrics and Orthodontics were included in the study. The study, however, was conducted on 28 children (17 girls and 11 boys—mean age = 10.16 ± 1.77) as 1 patient did not come to his appointments, and 1 patient wanted to quit the study. The sample was calculated by using Piface 1.72, and 28 people for each of the two groups guaranteed 82.2% power. This number was reached by considering the total discomfort VAS score variability (SD = 18.37) in the previous similar study.[13] In addition, true difference of means was estimated at 11, and type I error (α) was accepted as the standard value .05.

When including individuals in the study, patients who needed conventional impressions for the fabrication of a fixed or removable appliances in our department were selected in addition to the digital impressions taken as a routine diagnostic record. This was considered as a prerequisite. These individuals who met the pre-requisites were included in the study. The following criteria were also considered: not to have a history of digital or conventional impression taking, not to have temporomandibular joint and periodontal discomfort, and not to be using psychiatric or neuropathic drugs.

Prior to the study, the family or legal representatives of the patients signed an informed consent form, and also, approval for the study was obtained from the Ethics Committee of the Faculty of Dentistry of Marmara University (protocol no: 227/2018).

As with similar studies on the same subject,[3,13,14] the study was a crossover design and included digital and conventional

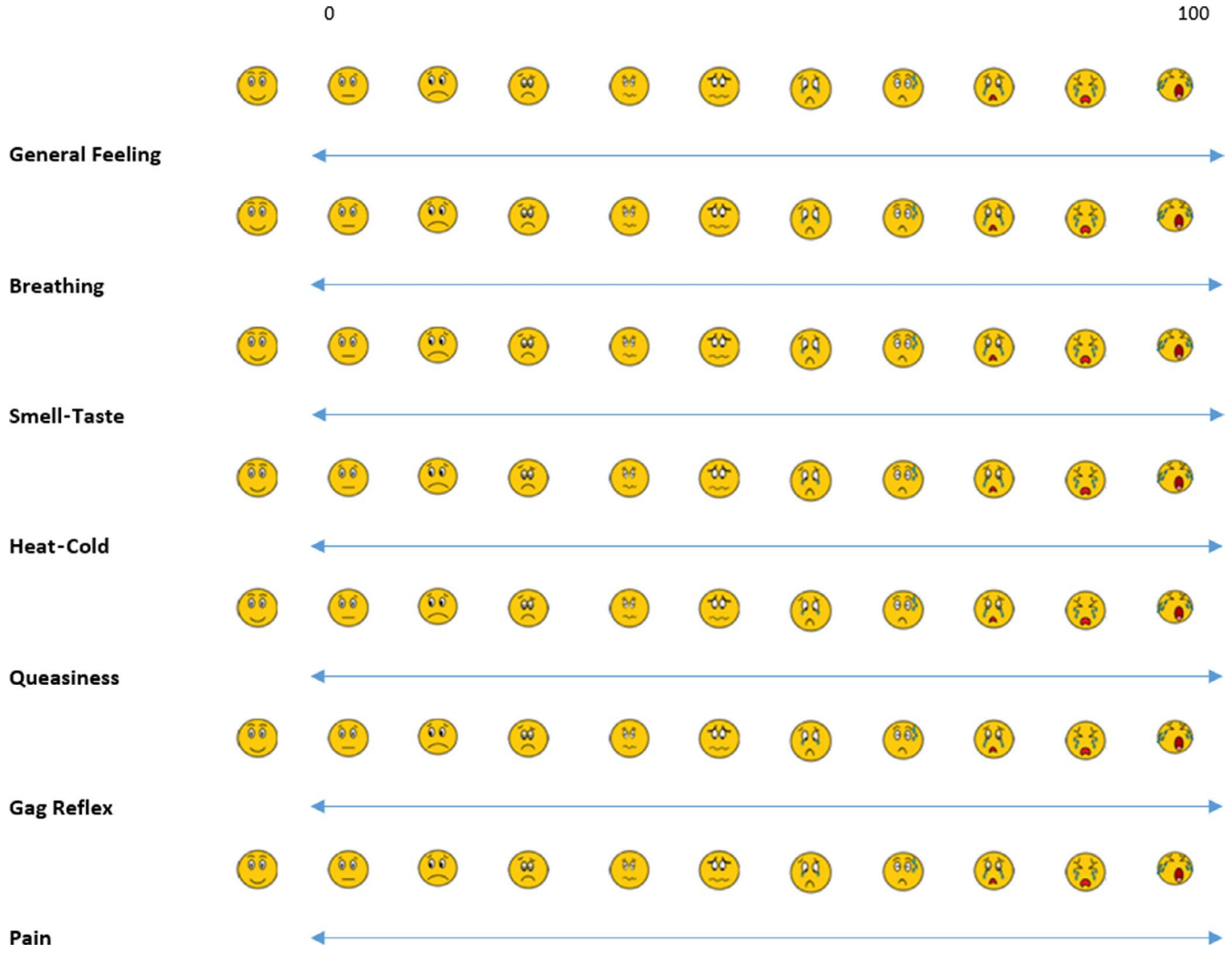

FIGURE 1 VAS index modified for children[24] to evaluate patient comfort in two impression methods

impressions taken by a one operator (HY) at 14- to 21-day intervals from the same patient. A section was created on the research follow-up form to be filled by the operator with regard to the both impression-taking methods. By using this section, the presence/absence of squeezing, hand/arm/foot movement, breathing difficulties, queasiness, gag reflex, vomiting, and crying in the patient was observed and scored between 0 and 100. Following that, in both impression-taking methods, in the section filled by the patient, the patient was asked to report his or her feeling of general discomfort, difficulty breathing, smell/taste discomfort, heat/cold disturbance, queasiness, gag reflex, and a pain spot. Unlike in other studies, in our study, the degrees of these parameters, however, were recorded by using a 100-mm VAS index, which was supported with facial emojis [24] designed specifically for children, instead of the classic VAS (Figure 1). Moreover, 14-21 days after the taking of impressions in both methods, the patients were asked to respond to questions in the questionnaire prepared to learn their preferences and experiences about the impressions.

All operations were carried out by the same operator (HY) with the experience of taking impressions at least 100 times in both impression methods and the same observer (MY) who conducted the control and recording procedures. To begin with, digital impressions were taken by using an up-to-date intraoral scanner (Trios 3-Cart, Color-2017, 3shape, Denmark)—by adhering to the scanning pattern recommended by the company —for routine diagnosis and recording. In the upper jaw, the occlusal, buccal, and lingual surfaces of the teeth and the palate were scanned. In the lower jaw, the occlusal, lingual, and buccal surfaces of the teeth were scanned in the order given. The intraoral scanning process was divided into the patient registration, lower jaw scan, upper jaw scan, and bite scan stages considering the progress of the process in the device. The time was paused by the observer at each stage and recorded separately. A follow-up appointment was arranged for the patient to visit the clinic 14-21 days later, and then, the patient underwent the conventional impression-taking procedure. Alginate (Hydrogum 5; Zhermack), which had been used routinely in the clinic,

TABLE 1 Comparison of the time taken for the impression in both methods

	Digital (N = 28)			Conventional (N = 28)					
Variables	**Mean**	**SD**	**SE**	**Mean**	**SD**	**SE**	***df***	***F***	***P***
Patient registration/tray selection	54.00	14.26	2.70	58.21	13.45	2.54	54.00	0.27	.26[a]
Upper jaw scan/impression	138.39	26.08	4.93	167.11	48.18	9.11	54.00	1.1	**.008**[a]
Lower jaw scan/impression	165.79	57.82	10.93	153.64	32.10	6.07	54.00	2.11	.34[a]
Bite scan/registration	106.75	34.24	6.47	71.29	17.88	3.38	40.7	12.8	**<.001**[a]
Total scan/impression	465.89	76.71	14.50	450.25	64.08	12.11	54.00	1.87	.41[a]

Bold values indicates statistical significance difference ($P<.05$).
Abbreviations: SD, standard deviation, SE, standard error.
[a]Student's *t* test, $P < .05$ Statistical significance from other group.

was used for conventional impression taking and was hand-mixed. Similarly, in the digital impression method, the same sequence of operations was recorded separately in the four stages: tray selection, lower jaw impression, upper jaw impression, and bite registration with wax. In both impression methods, care was taken not to allow any missing space on all occlusal, buccal, and lingual surfaces between the permanent first molars and the first molars. In the case of missing areas, the missing areas were scanned in the digital impressions, and impressions were retaken in the conventional method.

Statistical analyses were carried out in SPSS Statistics software (version 25.0; IBM Corp., ABD). Student's *t* tests ($\alpha = .05$) were used to analyse the mean differences between the comfort and time scores of the two methods when the data were normally distributed. Mann-Whitney *U* tests were used when the data were not normally distributed. The significance level was accepted as $P < .05$. The agreement between the patient's and the clinician's comfort perceptions was examined by using Pearson's correlation coefficient test.

3 | RESULTS

The mean age of the 28 paediatric patients included in the study was 10.16 ± 1.77 (range = 7.08-12.92), and 60.7% of them were girl, and 39.3% of them were boy. Table 1 shows the values of mean duration and standard deviations in these patients in different stages of impression taking in the digital and conventional groups. Mean durations of patient registration/tray selection, lower jaw scan/impression, and total scan/impression did not differ between the digital and conventional impression-taking groups ($P > .05$). The mean duration of the upper jaw scan/impression, however, was found significantly shorter in the digital impression group ($P = .008$), whereas the bite scan/registration took less time in the conventional impression group ($P < .001$; Table 1).

Table 2 shows the average comfort values and standard deviations of the digital and conventional impression groups. When these two groups were compared in terms of patient comfort, the total discomfort score ($P < .001$) filled by the clinician and the average VAS score ($P < .001$) filled by the patient were found to be more comfortable in the digital impression group (Table 2). When the correlation between the total discomfort score with seven different criteria, which was filled by the clinician, and the average VAS score filled by the patient were compared, the values were found to be similar in terms of assessing patient comfort ($r = .764$, $P < .001$; Table 3).

Table 4 shows the patients' preferences according to the questionnaire questions prepared for comparison of the two methods after the patients' impression experiences.

4 | DISCUSSION

The first null hypothesis that there were no significant differences between conventional and digital methods in terms of comfort was rejected. In fact, the total discomfort ($P < .001$) and the average VAS score ($P < .001$) that pointed to patient comfort were lower in the digital impression group. The second null hypothesis that the two methods were similar in terms of the time it took to take impressions was accepted because there was no difference when the total durations of the digital and conventional impression groups were compared ($P = .41$).

In a busy dentistry clinic, the total duration of impression taking not only affects which impression method the clinician chooses, but also patient comfort and preference. In this regard, Grunheid et al[12] have indicated that the fact that conventional impressions taken with alginate result in shorter chairside time compared with that of the digital impression method affects the patient's preference. They have linked why the patients in their study chose the conventional impression

TABLE 2 Comparison between the groups in respect to comfort of the two impression methods

Variables	Digital (N = 28)		Conventional (N = 28)			
Observation by clinician	**Mean rank**	**Sum of ranks**	**Mean rank**	**Sum of ranks**	**Z**	***P***
Squeezing	22.50	630.00	34.50	966.00	−3.32	**.001**[a]
Hand-foot movement	20.50	574.00	36.50	1022.00	−4.54	**<.001**[a]
Difficulty breathing	24.50	686.00	32.50	910.00	−3.03	**.002**[a]
Queasiness	19.50	546.00	37.50	1050.00	−5.10	**<.001**[a]
Gag reflex	23.50	658.00	33.50	938.00	−3.23	**.001**[a]
Vomiting	26.00	728.00	31.00	868.00	−2.32	**.020**[a]
Crying	27.00	756.00	30.00	840.00	−1.77	.078[a]

	Mean	SD	SE	Mean	SD	SE	*df*	*F*	*P*
Total discomfort score	7.14	7.27	1.37	43.88	29.85	5.64	30.1	34.3	**<.001**[b]

VAS scores by patient	**Mean rank**	**Sum of ranks**	**Mean rank**	**Sum of ranks**	**Z**	***P***
General discomfort	18.34	513.50	38.66	1082.50	−4.73	**<.001**[a]
Difficulty breathing	26.00	728.00	31.00	868.00	−1.29	.198[a]
Smell-taste discomfort	18.34	513.50	38.66	1082.50	−4.89	**<.001**[a]
Heat-cold discomfort	31.04	869.00	25.96	727.00	−1.21	.226[a]
Queasiness	18.79	526.00	38.21	1070.00	−4.73	**<.001**[a]
Gag reflex	23.14	648.00	33.86	948.00	−2.65	**.008**[a]
Pain	28.64	802.00	28.36	794.00	−0.073	.942[a]
Average VAS score	20.52	574.50	36.48	1021.50	−0.367	**<.001**[a]

Bold values indicates statistical significance difference ($P<.05$).

Abbreviations: SD, standard deviation; SE, standard error.

[a]Mann-Whitney U test, $P < .05$ Statistical significance from other group.

[b]Student's *t* test.

method to the fact that the conventional impression method is easier and faster. The conventional impression method has been found to be more effective also in other more recent research studies comparing the chairside times in the digital and conventional impression methods, although the difference is smaller.[3,7,10,22] In addition to that, the digital method has taken shorter in the research involving regional scanning[14] and complete arch scanning.[11,13] In a more recent study conducted using the same intraoral scanner as our study, they were concluded that the impression methods were similar in terms of chairside time.[23] In our present study, there was no difference in the total time required for the two impression-taking methods ($P = .41$). This may be associated with the shortening of the scanning times[12] due to the enhancement of operator experiences (hand and digital skills) with the widespread adoption of digital methods, as in the use of any other device. Moreover, because digital impression systems—as with any digital device—update themselves in terms of hardware and software, they emerge to be more effective today and in the future in terms of time, which should be considered normal. Besides, the second molar region, which is often difficult to scan because of the camera dimensions of intraoral scanning devices,[12] is not scanned in children; only between first molars, a narrower area is scanned. That is why the digital impression taking may have taken a shorter amount of time. Although not taken into consideration in this study, another variable that could influence the results of time investigation is packaging. In fact, some research took into consideration also packaging time for alginate impressions compared with the time needed to compress and send file to laboratory for digital models, showing a reduction in total time for digital impressions.[25]

A recent systematic review has been examined to determine which impression method was more effective in terms of working time and showed that there was no difference between the two methods. The authors, however, stated that the number of current studies conducted to date is limited and has high bias, and therefore, they emphasize the need for

TABLE 3 Correlation coefficients of patient scores with clinician score and total impression time

Variables	*r*	r^2	Correlation[a]	*P*
Discomfort score by clinician	.76	.58	Strong positive	**<.001**
Impression time				
Digital	.21	.04	Weak positive	.285
Conventional	.23	.05	Weak positive	.235

Bold values indicates statistical significance difference ($P<.05$).
Abbreviations: SD, standard deviation; SE, standard error.
[a]Pearson correlation coefficient test, *r*: Definition of coefficient of correlation
$P < .05$ Statistical significance from other group.

more current research.[26] In the present study, when all impression-taking stages were examined separately, the digital method was more effective compared with the conventional method in terms of the duration of scanning in the upper jaw arches ($P = .008$), but there was no significant difference between the two methods in terms of the lower jaw arch impressions ($P > .05$). This can be explained by the fact that when there are missing areas, impressions have to be retaken in the conventional impression methods[11,15] unlike in the digital impression method, in which intraoral scanners allow scanning of the missing areas. In the present study, the bite registration procedure, however, took shorter in the conventional impression method than in the other ($P < .001$). According to our experience in using intraoral scanners in paediatric patients, the duration of bite scan procedure from the buccal surfaces of the teeth increases due to the size of the scanner head, the low depth of the vestibular sulcus, and the presence of missing or erupting teeth.

The number of studies in which the effects of diagnosis and treatment on the quality of life of patients are assessed by patients has recently increased due to the fact that they provide perspective to clinicians.[16] In the research that examines the comfort of patients by using the VAS index, the digital impression methods have been found to be more comfortable[11,13,14,21-23] and preferred[3,7,12-14,21-23] by patients. The results of our study also support existing findings, and the digital impression method was found more comfortable for the patients ($P < .001$). In addition to the assessment of the impression method by the patients, patient comfort was observed by the clinician in order to strengthen the study. The patients' comfort states were observed by the clinician using seven different criteria as in the VAS index and scored from 0 to 100. The digital impression was found more comfortable in the clinician's assessment ($P < .001$) similar to the patient scores. Likewise, in the study of Gjelvold et al[11] patient comfort was assessed by both the clinician and the patient using the VAS index, and the digital impression method was found to be more comfortable in both assessments.

Impression comfort was seen to have a strong correlation when the agreement between the patient and clinician assessments was considered ($r = .764$). In the light of the results of this study, it can be said that the clinician's observation as well as the patient's observation is an important parameter in assessing patient comfort. In addition to this, it was checked whether the time required to take impressions affected patient comfort in the study, in addition to these criteria. The VAS score was weakly correlated with the time required to take impressions in the digital and conventional impression methods, with correlation coefficients of .209 and .232, respectively. Gjelvold et al[11] have carried out a study on 42 patients to examine the relationship between patient comfort and time, and found a similarly weak correlation. Although within the scope of these findings, time had an effect on patient comfort, and it can be said that it was weak and that most patients considered other factors.

Questionnaires that reflect patient experiences, satisfaction, and preferences emerging after the procedures of impression taking have been used in many research studies comparing the two methods.[3,7,10,12-15,21] In most such studies, patients were found to prefer the digital impression method [3,7,13-15,21]; in some of them, the preference was the conventional impression method, and in others, there were no differences.[10] In the study of Schepcke et al,[21] 82% of the patients preferred the digital impression technique more than the conventional method in complete arch scans. In the study of Burhandt et al[3] on adolescent patients, the digital technique was preferred more than the conventional method. In the study of Grunheid et al,[12] 73% of patients preferred the

TABLE 4 The results of the questionnaire asked to the patients about two impression methods

Questions	Digital (%)	No preference (%)	Conventional (%)
Which impression technique do you choose if you take another impression?	75.0	17.9	7.1
Which of the two impression methods was more comfortable?	82.1	10.7	7.1
Which impression method did you think took more time?	32.1	3.6	64.3
Which impression method did you become more stressed?	3.6	7.1	89.3

conventional impression method and expressed that alginate was easier and faster; the remaining 27% of the patients stated that they preferred the digital method because it was more comfortable. According to the questionnaire results of our study, 75% of the patients preferred the digital impression, and 82.1% of them stated that it was more comfortable.

Because our study examined different methods of impressions taken from the same patient at 14- to 21-day intervals (a crossover study), it has become easier to make comparisons in terms of clinicians and patients. In a number of studies, all impressions were taken in a single visit,[10,12] but this could cause a carry-over effect [3,15] and affect the results of the study. There are, however, studies comparing the same patients undergoing different impression methods in the literature.[12,13,15] There are also studies that examine different impression methods in different patients.[3,7,11] Moreover, in some studies in which the prosthetic approaches were investigated, the impression method was only used regionally,[14] and the complete arches were scanned in orthodontics studies.[3,7,12] Because impressions are usually taken from complete arches for appliance fabrication and diagnostic recording in the field of orthodontics and paediatric dentistry, and in order to provide standardization for the comparison of the two methods, impressions were taken from complete arches in a way similar to other studies.

Operator experience can play an important role in studies comparing patient comfort and the time required to take impressions in different methods.[3,14,15] This is because the operator's being more experienced in any method of taking impressions can affect patient comfort and the time required to take impressions. Considering the existing studies, although many research studies involve a single operator,[3,11-13,21] there are studies involving different operators.[7,10] To improve the reliability of the results in our study, all impressions were taken by a single experienced operator who had taken impressions at least 100 times in both impression methods. Moreover, the scanning pattern used in the digital impression methods is an important issue and can affect the accuracy of impression and the time required to take impressions.[12,27] Therefore, the scanning pattern that the 3shape company recommended for upper and lower jaw scans was used in our study.

The first limitation of our study was that the digital and conventional impression methods were not used by different operators. This is because although an experienced single operator was employed, operators with similar experience may have a tendency towards digital or conventional methods. Moreover, testing inexperienced operators in different impression methods could also enhance the scope of the study. For example, although Ko et al[28] compared the time spent making the plans on the impression methods instead of impression-taking time, they enhanced the scope of their study using different operators (16 orthodontist). The second limitation was that, in our study, a single intraoral scanner was used to take impressions and a single conventional impression was hand-mixed. Other intraoral scanners and other conventional impression types and mixing methods (mixing by using a machine) were not employed. This is because the results could have changed again in favour of an impression method due to the improvements in both digital and conventional impressions of different brands and methods.

5 | CONCLUSION

Within the scope of the findings of this study,

- Although digital impressions and conventional impressions had superiorities in different stages of impression taking, the both methods were similar in terms of the time required to take impressions.
- When the comfort of the impression methods was assessed using the VAS score by the children and the observer clinician, the digital impression method was considered to be more comfortable than the conventional method in both scoring methods.
- According to the questionnaire inquiring the preference for the method of impression taking, most of the children preferred the digital method.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTION

HY conceived the ideas; HY and MNA. collected the data; H.Y analysed the data; and HY and MNA. led the writing.

ORCID

Hakan Yilmaz https://orcid.org/0000-0002-9564-6212
Merve Nur Aydin https://orcid.org/0000-0001-9388-8069

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How to cite this article: Yilmaz H, Aydin MN. Digital versus conventional impression method in children: Comfort, preference and time. *Int J Paediatr Dent*. 2019;29:728–735. https://doi.org/10.1111/ipd.12566