RESEARCH PAPER

Comparative Analysis of Patient Comfort and Reliability in Mixed Dentition Assessment: Intraoral Scanners vs. Traditional Alginate Impressions

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Background: Mixed dentition analysis plays a critical role in early orthodontic diagnosis and treatment planning. Traditional alginate impressions (TAI) have been widely used; however, intraoral scanners (IOS) offer a digital alternative with potential advantages in accuracy and patient comfort, particularly in pediatric populations.

Aim: To compare patient comfort and the reliability of mixed dentition space analysis using intraoral scanners versus traditional alginate impressions.

Materials and Methods: This cross-sectional analytical study included 10 children aged 9-12 years in the mixed dentition stage. The maxillary and mandibular arch was recorded using alginate impressions and an intraoral scanner. Mixed dentition analysis was performed using Moyers' and Tanaka-Johnston methods on diagnostic casts and digital models. Patient comfort was assessed using a five-point Likert scale. Statistical analysis was performed using the Wilcoxon signed-rank test and Chi-square test ($p \leq 0.05$).

Results: Intraoral scanning was rated more comfortable by 6 of 10 participants. In Moyer's analysis, statistically significant differences were observed between IOS and TAI for both available space ($p = 0.042$) and required space ($p = 0.033$). Similarly, for Tanaka–Johnston analysis, a significant difference was noted in available space ($p = 0.04$), though not in required space ($p = 0.206$). IOS consistently demonstrated lower variability and slightly reduced measurements compared to TAI.

Conclusion: Intraoral scanners provide a more comfortable and efficient alternative to traditional alginate impressions, with comparable or superior reliability in mixed dentition analysis. Their use enhances patient experience, reduces operator dependency, and supports a shift toward digital workflow in pediatric dentistry.

Keywords: - humans, child, dentition, mixed, alginates, Pediatric Dentistry, Cross-Sectional Studies, Patient Comfort, Patient Outcome Assessment, Dentists

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Introduction

Accurate assessment of the mixed dentition stage is a cornerstone of pediatric dentistry and early orthodontic diagnosis, as it provides essential information regarding arch length discrepancies, eruption patterns, space availability, and the early identification of developing malocclusions. Reliable mixed dentition analysis allows clinicians to institute timely interceptive measures,

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potentially reducing the severity and complexity of future orthodontic treatment and improving long-term occlusal outcomes [1,2].

Conventional alginate impressions have traditionally been the method of choice for obtaining diagnostic casts used in mixed dentition analysis. Alginate is favored for its low cost, ease of manipulation, and widespread clinical acceptance. However, its inherent limitations are well documented. Alginate impressions are technique-sensitive, dimensionally unstable, and prone to distortion due to improper mixing, delayed pouring, storage conditions, or patient movement during impression taking [3]. In pediatric patients, additional challenges such as gag reflex, anxiety, unpleasant taste, and limited cooperation may further compromise impression accuracy and negatively influence the child's dental experience [4].

Advances in digital dentistry have led to the increasing use of intraoral scanners (IOS) as an alternative to conventional impression techniques. IOS enable direct three-dimensional acquisition of dental arches, producing highly detailed digital models that can be stored, analyzed, and integrated seamlessly with orthodontic software. The elimination of impression trays and materials offers improved patient comfort and reduced chairside stress, making IOS particularly appealing in pediatric populations [5,6]. Digital models generated by IOS have demonstrated high accuracy and reproducibility for orthodontic measurements, arch length analysis, and space assessment, with the added advantages of reduced operator dependency and elimination of material-related distortion [7].

While substantial evidence supports the accuracy and reliability of intraoral scanners in adult orthodontic patients, their application in pediatric dentistry—particularly during the mixed dentition phase—remains comparatively underexplored. The mixed dentition stage presents unique clinical challenges, including partially erupted teeth, variable crown morphology, smaller dental arches, and limited patient cooperation, all of which may influence scanning accuracy and reliability [8]. Moreover, the existing literature provides limited consensus regarding whether IOS can consistently match or surpass conventional alginate impressions in mixed dentition space analysis, especially when commonly used predictive methods such as Moyers' and Tanaka–Johnston analyses are employed.

In addition to diagnostic reliability, patient comfort has emerged as an important outcome measure in pediatric dental care. A positive dental experience during childhood plays a crucial role in shaping long-term attitudes toward dental treatment and compliance with orthodontic therapy [9]. Therefore, evaluating both the accuracy of diagnostic measurements and the subjective comfort experienced by pediatric patients is essential when comparing impression techniques.

Thus, the present study was undertaken to compare patient comfort and the reliability of mixed dentition space analysis obtained using an intraoral scanner and traditional alginate impressions in children.

Materials and methods

Study design and ethical approval

The study was conducted between December 2024 to January 2025 in children aged between 9-12 years in the Department of Pediatric and Preventive Dentistry, Sathyabama Dental College and Hospital, Chennai, Tamil Nadu, India. Prior to the commencement of the study, approval was obtained from the Institutional Ethics Committee of Sathyabama Institute of Science and Technology (Ref: 458/IRB-IBSEC/SIST; dated 10th December 2024).

Sample Size and Selection Criteria

A total of 10 children were recruited for the present study based on a previous study done by Abirami S et al. (10) considering a 5% level of significance, a study power of 0.8. Children were selected using a systematic random sampling who met the inclusion criteria.

Caries-free, healthy children requiring routine pediatric and orthodontic evaluation were included in the study having cooperative behavior (Frankl's Behavior Rating Scale scores of 3 or 4), had fully erupted permanent mandibular incisors and permanent molars in both arches, and presented with at least one deciduous tooth in each quadrant. Written informed parental consent and child assent was obtained in accordance with ICMR guidelines. Children with severe crowding, abnormal tooth inclination or rotation, congenitally missing or supernumerary teeth, or any congenital craniofacial anomalies were excluded from the study.

A trained pediatric dentist serving as a blinded investigator to minimize bias in data collection and interpretation carried out all clinical procedures. During the first appointment, alginate impression was taken using irreversible hydrocolloid (Orikam Neoalgin®), with maxillary and mandibular impressions poured immediately to obtain diagnostic casts. After a one-week interval, the participants' digital impression was recorded using the Ray IOS® intraoral scanner for both the arches and the images were stored in SDL files. Following both procedures, each child rated their comfort for both techniques using a five-point Likert scale.(Figure 1,2)

Figure 1- Alginate impression and digital impression being recorded.

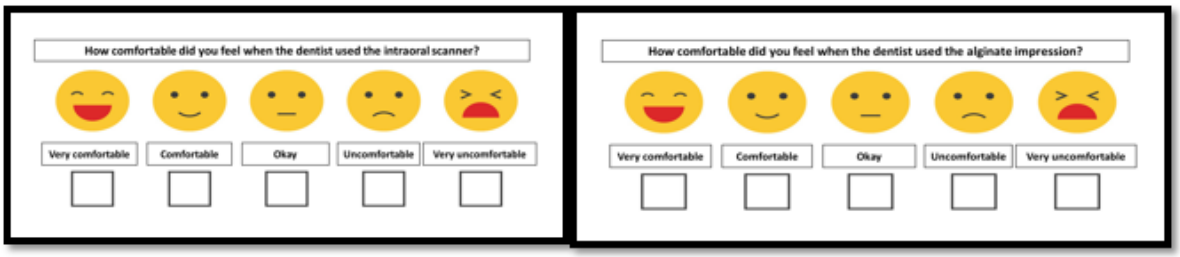

Figure 2- Likert scale used

Parameters assessed were patient comfort and mixed dentition space analysis which was done for both diagnostic casts and digital casts using two standard methods:

1. Moyers' Mixed Dentition Analysis(12)
2. Tanaka–Johnston Mixed Dentition Analysis(12)

For manual measurements on diagnostic casts, a digital vernier caliper was used. For digital models, measurements were recorded using the Meshmixer® application (Autodesk Inc., USA)

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). The Wilcoxon signed-rank test was used to compare measurements obtained from Moyers' and Tanaka–Johnston mixed dentition analyses between diagnostic casts and digital casts, while differences in patient comfort assessed using the Likert scale was analyzed with the Chi-square test, with statistical significance set at $p \leq 0.05$.

Results

The study sample consisted of 10 children in the mixed dentition stage, with a mean age of 9.36 ± 1.44 years with 6 girls and 4 boys.

Assessment of patient comfort using a five-point Likert scale demonstrated a statistically significant difference between the two impression techniques.(Table 1)

Likert scale	Alginate impression	Intra oral scanning	Total	p-value
1(Very comfortable)	0	5	5	0.049*
2(Comfortable)	3	3	6	-
3(Okay)	2	2	4	-
4(Uncomfortable)	5	0	5	-
5(Very uncomfortable)	0	0	0	-

Comparison of measurements obtained from alginate impressions and intraoral scanner–generated digital models demonstrated differences across mixed dentition analyses. In Moyers' mixed dentition analysis, statistically significant differences were observed between the two impression methods for both space available and space required.(Table 2 and Table 3) Similarly, in Tanaka–Johnston mixed dentition analysis, a statistically significant difference was noted for space available between alginate impressions and intraoral scanning. However, no statistically significant difference was observed between the two methods for Tanaka–Johnston space required.(Table 4 and Table 5). Overall, intraoral scanner measurements showed slightly lower values with reduced variability compared to alginate impressions.

Comparison of space available and space required measurements obtained using alginate impressions and

intraoral scanner–generated digital models using Moyers' mixed dentition analysis. (Table 2, Table 3)

Moyers Mixed dentition analysis space available(mm)	N	Mean	Std. Deviation	P value
Alginate impression	10	45.964	3.3910	0.042*
Intraoral scanner	10	45.772	3.3115	

Moyers Mixed dentition analysis space required(mm)	N	Mean	Std. Deviation	P value
Alginate impression	10	46.164	3.1906	0.033*
Intraoral scanner	10	45.972	2.9151	

Comparison of space available and space required measurements obtained using alginate impressions and intraoral scanner–generated digital models using the Tanaka–Johnston mixed dentition analysis (Table 4, Table 5)

Tanaka Johnston analysis space available (mm)	N	Mean	Std. Deviation	P value
Alginate impression	10	45.964	3.3910	0.04*
Intraoral scanner	10	45.672	3.3115	

Tanaka Johnston analysis space required(mm)	N	Mean	Std. Deviation	P value
Alginate impression	10	45.820	3.2361	0.206
Intraoral scanner	10	45.476	3.0280	

Discussion

Mixed dentition analysis plays a pivotal role in pediatric dentistry and orthodontics by enabling early detection of space discrepancies and developing malocclusions, thereby facilitating timely interceptive orthodontic planning [1,2]. The accuracy of such analysis is highly dependent on the quality of diagnostic records, making the choice of impression technique clinically relevant.

Conventional alginate impressions have traditionally been used for mixed dentition analysis due to their low cost and ease of use; however, they are inherently technique-sensitive and susceptible to dimensional distortion resulting from improper manipulation, delayed pouring, and material instability [3]. These limitations are particularly pronounced in pediatric patients, where gag reflex, anxiety, and limited cooperation may further compromise impression accuracy. In contrast, intraoral scanners enable direct three-dimensional acquisition of dental arches, eliminating impression material–related errors and providing reproducible digital models suitable for precise space analysis [5,7].

Patient comfort was evaluated as an outcome measure because it directly influences cooperation and the overall success of pediatric dental procedures. The present study demonstrated significantly better comfort scores for intraoral scanning compared with alginate impressions. This finding may be attributed to the absence of impression trays, unpleasant taste, and gag-inducing materials during digital scanning. Improved patient comfort with intraoral scanners has been consistently reported in pediatric and orthodontic literature, highlighting their child-friendly nature and potential to enhance acceptance of diagnostic procedures [9,6].

Moyers' and Tanaka–Johnston mixed dentition analyses were selected due to their widespread clinical use and reliability in predicting the mesiodistal widths of unerupted permanent teeth during the mixed dentition stage [12,13]. These analyses are routinely employed in clinical practice, making them appropriate tools for comparing the diagnostic reliability of conventional and digital impression techniques.

The statistically significant differences observed in certain parameters between alginate impressions and intraoral scanning may be attributed to minor

dimensional inaccuracies inherent to conventional impression materials. However, these differences were small and within clinically acceptable limits, suggesting that both methods are reliable for mixed dentition space analysis and unlikely to alter clinical decision-making [14]. The absence of a significant difference in Tanaka–Johnston space required further supports the diagnostic equivalence of the two techniques. Notably, intraoral scanner measurements exhibited reduced variability, indicating greater consistency, which is advantageous in longitudinal monitoring and digital workflow integration [15,8].

Overall, the findings of this study support the clinical applicability of intraoral scanners as a reliable alternative to alginate impressions for mixed dentition analysis, with the added benefit of improved patient comfort. The adoption of digital impressions in pediatric dentistry may therefore enhance both diagnostic efficiency and patient-centered care.

Conclusion

Intraoral scanning demonstrated comparable reliability to conventional alginate impressions for mixed dentition analysis while providing significantly improved patient comfort. These findings support the use of intraoral scanners as a clinically acceptable and child-friendly alternative for mixed dentition assessment in pediatric dental practice.

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