International Journal of Dental Sciences
www.dentaljournal.in
E-ISSN: 2663-4708
Received: 04-07-2026; Accepted: 04-08-2026; Published: 19-08-2026
Volume 8, Issue 3, 2026, Page No. 116-119

Comparison of traditional and DSLR Photogrammetric method for the Tanaka Johnston mixed dentition analysis

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DOI: https://doi.org/10.66856/ijds.2026.8.3.8100

Abstract
Background: Mixed dentition analysis is essential for diagnosis and treatment planning in children. The Tanaka Johnston method remains widely used but is traditionally applied on plaster models, which are time-consuming and require storage. Digital models exist but are expensive and less accessible in developing countries. DSLR photogrammetry may offer a cost-effective alternative.
Aim: To compare the accuracy, efficiency and practicality of Tanaka Johnston mixed dentition analysis using traditional plaster models and DSLR photogrammetric method.
Methods: Thirty-five children aged 8–14 years with Class I molar and canine relationships were included. Alginate impressions were made and plaster casts were measured using a digital Vernier caliper. Intraoral occlusal photographs were taken with a DSLR (Canon EOS 1500D) using an occlusal mirror. Images were processed with software for calibrated tooth measurements. The Tanaka Johnston equation was applied to both methods. Paired t-tests and Pearson correlation were used for statistical comparison.
Results: No statistically significant differences were found between the two methods ($p > 0.05$). Mean discrepancies ranged from 0.1–0.3 mm considered clinically insignificant. Correlation was high ($r = 0.97$).
Conclusion: DSLR photogrammetry is accurate, efficient and practical for mixed dentition analysis. It provides a low-cost, accessible alternative to plaster models and advanced digital scanners, especially in developing countries.
Clinical Significance: DSLR photogrammetric measurements showed strong correlation ($r = 0.97$) and minimal differences from conventional plaster models, indicating their reliability for mixed dentition assessment. This method provides a precise, non-invasive and cost-effective alternative for orthodontic diagnosis and treatment planning.

Keywords: Tanaka Johnston analysis, mixed dentition, DSLR photogrammetry, plaster models, digital dentistry

Introduction
Mixed dentition analysis plays a pivotal role by predicting the mesiodistal dimensions of unerupted teeth and assessing the available space within the dental arch. Accurate analysis ensures timely diagnosis of tooth size–arch length discrepancy (TSALD), enabling interceptive orthodontic interventions such as space maintenance, eruption guidance and serial extraction [1, 2]
Several predictive methods exist, including Moyers' probability tables, Huckaba's approach and the Tanaka Johnston analysis. [3, 4] Among these, the Tanaka Johnston method, proposed in 1974, has become one of the most widely adopted due to its simplicity, limited armamentarium requirements and acceptable reliability across populations [5]. It involves measuring the sum of the mandibular incisors and applying regression equations to estimate the widths of unerupted canines and premolars.
Traditionally, Tanaka Johnston analysis is conducted on plaster models derived from alginate impressions. Although accurate, this process is labor-intensive and involves impression taking, cast pouring, trimming and storage. Casts are susceptible to distortion, breakage and require large storage spaces over time [6, 7]. Manual measurement with calipers can introduce operator variability and human error.
Photogrammetry, which extracts precise measurements from photographs, has gained increasing relevance in dentistry. DSLR cameras, already widely used for clinical documentation, can produce high-resolution images suitable for measurement when combined with calibration and analysis software [10, 11]. Unlike intraoral scanners, DSLR photogrammetry requires minimal additional investment, making it more accessible.
Studies have shown that digital photographic measurements can achieve accuracy comparable to plaster model analysis [12]. Furthermore, digital image storage is convenient, prevents cast deterioration and facilitates case sharing among professionals.
Given the limitations of plaster models and the high costs of digital scanners, DSLR photogrammetry represents a promising intermediate solution. This study aimed to compare the accuracy and efficiency of traditional plaster-based Tanaka Johnston analysis with DSLR photogrammetric method.

Materials and Methodology

This prospective comparative in *f* study was conducted in the Department of Pedodontics and Preventive Dentistry at Ahmedabad Dental College and Hospital. Ethical clearance was obtained and informed consent was taken from the parents or guardians of all participants. Ethical clearance for the study was obtained from the Institutional Ethics Committee (IECADC/0110/2025).

Thirty-five patients aged between 8 and 14 years were included in the study. Inclusion criteria required participants to be within the specified age range, having Class I molar and canine relationships, minimal malocclusion such as mild spacing or crowding and intact contact points. Exclusion criteria included patients younger than 8 or older than 14 years, teeth with proximal caries, fractures, or morphological anomalies, signs of attrition or abrasion due to parafunctional habits and the presence of craniofacial anomalies.

The materials used in the study included a DSLR camera (Canon EOS 1500D), an occlusal mirror, alginate impression material and trays, dental stone, a digital Vernier caliper with ±0.01 mm accuracy, a mixing bowl, spatula and Meditlink software. The procedure involved two methods for measuring mesiodistal tooth dimensions.

In the traditional method, alginate impressions were taken and poured with dental stone to prepare casts. Measurements were taken manually using a digital Vernier caliper. Mesiodistal Diameter (MDD) of four mandibular Incisor was taken and the Tanaka-Johnston regression equations were applied to predict tooth sizes: for the maxillary arch, the formula was (sum of mandibular incisors ÷ 2) + 11 mm and for the mandibular arch, it was (sum of mandibular incisors ÷ 2) + 10.5 mm.

In the DSLR photogrammetric method, standardized occlusal photographs were captured using the DSLR camera and an intraoral occlusal mirror. Camera settings were standardized for focal length, aperture and lighting. The images were exported to a computer, calibrated using a reference scale and analyzed with Meditlink software to obtain mesiodistal measurements. The same Tanaka-Johnston equations were applied to derive predicted values. Statistical analysis was performed using paired t-tests to compare mean values between the two methods and Pearson's correlation coefficient was used to assess agreement.

Results

The study sample included 35 patients (17 males, 18 females), with a mean age of 11.2 years. Measurements obtained from DSLR images were comparable to plaster models. Differences ranged from 0.1–0.3 mm, with no statistically significant differences ($p > 0.05$). Strong correlation was observed between the two methods (r=0.97). 35 participants were evaluated for Tanaka Johnston mixed dentition analysis. Out of which 17 were male and 18 were female participants. An unpaired t-test comparing the mean mesiodistal diameter of the four mandibular incisors, as well as the predicted widths of the maxillary and mandibular canines and premolars between the two groups, revealed no statistically significant differences (p value > 0.05) for all parameters, indicating that both groups had similar outcomes as indicated in Table 1**.**

The Chi-square (χ^2) test of proportion was employed to assess the frequency and percentage distribution of study participants based on maxillary and mandibular inference types. As presented in Figure 2 and Table 2, the results revealed statistically significant differences ($p < 0.05$) between the maxilla and mandible inference within the same group.

Table and table legends

Table 1: Intergroup comparison of different parameters between two groups

Parameter	Groups	Mean ± SD	t	p value
Maxillary total arch length	Traditional method	74.91 ± 4.62	1.072	0.79
	DSLR photogrammetric method	74.55 ± 4.75		
Mandibular total arch length	Traditional method	65.49 ± 2.98	0.273	0.54
	DSLR photogrammetric method	65.56 ± 3.02		
MDD of four mandibular incisors	Traditional method	22.23 ± 1.37	0.671	0.13
	DSLR photogrammetric method	22.04 ± 1.52		
Predicted width in maxilla	Traditional method	27.73 ± 1.37	0.671	0.13
	DSLR photogrammetric method	27.54 ± 1.52		
Predicted width in mandible	Traditional method	27.48 ± 1.37	0.671	0.13
	DSLR photogrammetric method	27.29 ± 1.52		

Table 2: Frequency and percentage distribution of study participants according to type of inference in maxilla and mandible amongst different groups

Inference	Traditional Method				DSLR Photogrammetric Method			
	Maxilla		Mandible		Maxilla		Mandible	
	(n)	%	(n)	%	(n)	%	(n)	%
Available space < required space	15	42.86	16	45.71	14	40	18	51.43
Available space = required space	1	2.86	2	5.71	4	11.43	2	5.71
Available space > required space	19	54.29	17	48.57	17	48.57	15	42.86
Total	35	100	35	100	35	100	35	100

Figure and figure legends

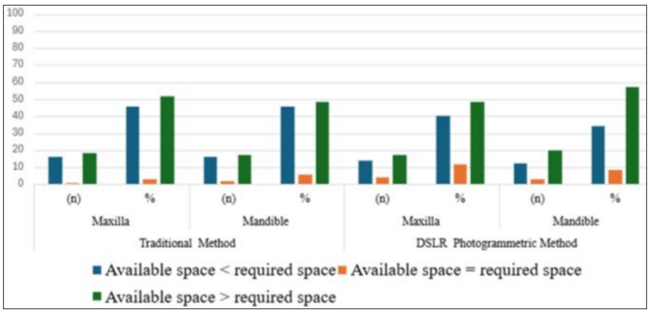

Fig 1: Frequency and percentage distribution of study participants according to type of inference in maxilla and mandible among different groups

Discussion

This study demonstrated that DSLR photogrammetry provided accuracy comparable to traditional plaster-based Tanaka Johnston analysis, with the added benefits of efficiency and practicality. The findings aligned with studies validating digital models against conventional casts. Zilberman *et al* [6] and Stevens *et al* [11] reported no significant differences between manual and digital measurements. Similarly, Rossini *et al* [8] concluded in a systematic review that digital models are as accurate as plaster models, with advantages in storage and accessibility.

Padmanabh *et al* [12] found mobile photogrammetry to be a reliable and valid alternative to traditional methods for measuring tooth width in Tanaka Johnston mixed dentition analysis. Rheude B *et al* [13] found statistically significant differences between plaster and digital orthodontic models, though the changes were minor and clinically insignificant.

The time efficiency of DSLR photogrammetry is especially valuable in pediatric settings, where patient cooperation is often limited. Eliminating the need for impressions and plaster casts reduces chairside and laboratory time, improving patient experience. Digital images can be easily shared for interdisciplinary consultation or remote diagnosis. The comparison between the traditional method and the DSLR photogrammetric method revealed no statistically significant differences across all measured parameters.

The mean values for maxillary and mandibular total arch lengths, MDD of four mandibular incisors and predicted widths in both maxilla and mandible were similar in both groups (all $p > 0.05$). This indicated that the DSLR photogrammetric method provided measurements consistent with those obtained using the traditional approach, supporting its reliability and potential use as a valid alternative for dental arch assessments.

Previous investigations by Gholston *et al* [14] and Normando *et al* [15] have validated the reliability of photogrammetric techniques for clinical and research-based evaluations of tooth dimensions and dental arch widths. Mullen *et al* [16] confirmed that E-model software yielded dentition measurements and Bolton ratios with comparable accuracy and efficiency to digital callipers used on plaster models. The present study evaluated these parameters across two groups.

Storage of plaster casts has long been a challenge, particularly in academic and large clinical setups where hundreds of models accumulate annually. Digital photography eliminates these concerns, requiring only electronic storage. In addition, DSLR cameras are versatile and commonly used in dental practice, making the transition straightforward.

High costs associated with intraoral scanners and 3D printing restrict their adoption in resource-limited settings. DSLR photogrammetry offers a feasible alternative, using equipment that many institutions already possess.[10] Once standardized, the method requires minimal additional training.

Conclusion

DSLR photogrammetry provides a reliable, efficient and practical alternative to traditional plaster-based Tanaka Johnston analysis. Its accuracy is comparable, while its reduced time, cost and storage requirements make it particularly valuable in developing nations. This method bridges the gap between conventional models and advanced digital technologies, offering a pragmatic solution for mixed dentition analysis.

Clinical Significance

The findings indicate that DSLR photogrammetric measurements are highly comparable to conventional plaster model analyses, with minimal differences and strong correlation (r = 0.97). This suggests that DSLR-based digital methods can reliably replace traditional model analysis for mixed dentition assessment. The technique offers a precise, non-invasive and cost-effective alternative for clinical orthodontic diagnosis and treatment planning.

List of Abbreviations

DSLR: Digital Single-Lens Reflex
EOS: Electro-Optical System.
TSALD: Tooth size–arch length discrepancy
MDD: Mesiodistal Diameter
3D: Three Dimensional

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