COMPARATIVE EVALUATION OF FLEXURAL STRENGTH OF TWO STAINLESS STEEL PRE-FORMED SPACE MAINTAINERS- AN IN VITRO STUDY

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ABSTRACT

Background:

Premature loss of primary teeth often results in space discrepancies and malocclusion, making space maintainers an essential component of pediatric dentistry. Preformed stainless steel space maintainers have gained popularity due to their ease of use, durability, and reproducibility. However, the clinical performance of these appliances is highly dependent on their flexural strength, which determines their resistance to deformation under masticatory forces.

Aim:

The present study aimed to compare the flexural strength of two commercially available preformed stainless steel space maintainers—Kedo-S Fit and Kids E Dental—using an Instron universal testing machine.

Materials and Methods:

A total of 20 preformed stainless steel space maintainers were tested, with 10 samples allocated to each group: Group 1 – Kedo-S Fit and Group 2 – Kids E Dental. The samples were subjected to a cantilever flexural bending test on the Instron machine at a crosshead speed of 1 mm/min, with the point of load application set at 10 mm. The maximum force required to cause failure was recorded. Data were analyzed using an independent t-test, with the level of significance set at $p < 0.05$.

Results:

The mean flexural strength of Kedo-S Fit was 48.6 ± 3.2 N, while Kids E Dental demonstrated a mean of 46.9 ± 3.5 N. Statistical analysis revealed no significant difference between the groups ($t = 0.92$, $p = 0.37$). However, Kedo-S Fit exhibited marginally higher values.

Conclusion:

Both systems showed adequate flexural strength, confirming their clinical reliability. Kedo-S Fit demonstrated slightly superior mechanical resistance, which may provide an additional margin of durability in functional conditions.

Keywords:

Pediatric dentistry, Space maintainer, Stainless steel, Flexural strength, Kedo-S Fit, Kids E Dental, Instron testing, Mechanical properties, Child health.

How to cite this article: Natarajan B, Jeevanandan G. Comparative Evaluation of Flexural Strength of Two Stainless Steel Pre-Formed Space Maintainers - An In Vitro Study. Int J Drug Deliv Technol. 2026;16(62s): 2016-2021. DOI: 10.25258/ijddt.16.62s.203

INTRODUCTION

Premature loss of primary teeth continues to be a major concern in pediatric dentistry, as it often leads to space discrepancies, altered eruption sequences, and the development of malocclusion in the permanent dentition.[1,2] To address these challenges, space maintainers are widely used to preserve arch length and ensure proper alignment of the erupting permanent teeth.[3] Among the available designs, preformed stainless steel space maintainers remain a popular choice due to their ease of use, durability, and favorable cost-to-benefit ratio.[4,5]

The long-term clinical success of space maintainers depends greatly on their ability to withstand functional intraoral forces without distortion or fracture.[6,7] Consequently, the assessment of flexural strength has become a critical method for evaluating their mechanical reliability.[8] Stainless steel has consistently been the material of choice for these appliances because of its high tensile strength, corrosion

resistance, and biocompatibility.[9,10] However, differences in manufacturing processes and material finishing across commercially available brands may influence their performance and longevity.[11]

Recent advances in pediatric dental products have led to the introduction of newer preformed stainless steel space maintainers, such as Kedo-S Fit, which are specifically designed to improve adaptation and clinical efficiency. In contrast, appliances such as those from Kids E Dental represent commonly used conventional systems with established clinical reliability. Despite their frequent use, limited evidence is available comparing the mechanical strength and performance of these systems, making it necessary to establish scientific data that supports clinical decision-making.[12,13]

The present study was undertaken to compare the flexural strength of Kedo-S Fit and Kids E Dental preformed stainless steel space maintainers using an Instron universal testing machine. By evaluating and comparing their resistance to deformation, the study seeks to provide valuable insights into their mechanical performance, enabling pediatric dentists to make evidence-based choices in space management.

MATERIALS AND METHODS

Study Design and Ethical Considerations

This laboratory-based in vitro comparative experimental study was executed at the Research Laboratory in a dental institution in Chennai. Ethical clearance was obtained from the Institutional Scientific Review Board prior to study initiation (Approval No.: SRB/SDC/PEDO-2304/24/110). The investigation commenced in April 2025 and was completed over a duration of four weeks. The timeframe encompassed the preparation of samples and execution of the study.

Sample size estimation:

The sample size was calculated with reference to the methodology adopted by Kulkarni et al. in their study .Following this precedent, the present study included 10 samples in each group (N = 20). This sample size is considered appropriate for detecting clinically relevant differences in flexural strength in an in-vitro design, while also serving as a pilot framework for future large-scale studies.[14]

Preparation of Samples

A total of 20 stainless steel preformed space maintainers were selected for the study and divided into two groups (n = 10 each). Group 1 consisted of Kedo-S Fit stainless steel preformed space maintainers, and Group 2 consisted of Kids E Dental stainless steel preformed space maintainers.

Each space maintainer was inspected visually for manufacturing defects, surface irregularities, and dimensional consistency before testing. To ensure uniformity, all samples were standardized in terms of size and morphology as supplied by the manufacturers. The appliances were carefully positioned and stabilized to replicate their clinical orientation prior to mechanical testing.

For testing, the samples were mounted on a custom jig designed to fit the Instron Universal Testing Machine.(Figure 1) The positioning was carried out so that the load was applied at the midpoint of the occlusal bar in a three-point bending test configuration, simulating intraoral occlusal forces. The span length between the supports was standardized across all samples. Prior to loading, each sample was securely fixed to avoid any movement during force application.

Flexural test

The samples were subjected to a flexural bending test on the Instron Universal Testing Machine. The crosshead speed was maintained at 1 mm/minute, and the displacement was standardized at 10 mm. The maximum force required to produce fracture or permanent deformation of each stainless steel preformed space maintainer was automatically recorded by the system.

All specimens were tested under identical laboratory conditions to ensure standardization and reproducibility of results. The recorded values were expressed in Newtons (N), and the mean and standard deviation were calculated for each group.The flexural strength and deflection at maximum load were recorded automatically by the software integrated with the testing machine.(Figure 2)

All procedures were carried out under controlled laboratory conditions to minimize variability. The mean values and standard deviations for each group were calculated, and the data were subjected to appropriate statistical analysis to compare the performance between the two groups.

STATISTICAL ANALYSIS

The collected data were entered into IBM SPSS Statistics (version 23, IBM Corp) for statistical analysis. Descriptive statistics, including mean, standard deviation (SD), and 95% confidence intervals (CI), were calculated for both groups. The normality of the data distribution was assessed using the Shapiro–Wilk test, which confirmed normal distribution ($p > 0.05$). An independent sample t-test was performed to compare the flexural strength between the two groups. A p-value < 0.05 was considered statistically significant.

RESULTS

The mean flexural strength of Kedo-S Fit stainless steel preformed space maintainers was 48.6 ± 3.2 N, whereas Kids E Dental space maintainers exhibited a mean flexural strength of 46.9 ± 3.5 N. The 95% confidence intervals for Kedo-S Fit (46.5–50.7 N) and

Kids E Dental (44.6–49.2 N) demonstrated a slight numerical advantage for Kedo-S Fit. However, independent t-test analysis revealed no statistically significant difference between the two groups ($t = 0.92$, $p = 0.37$).(Table1)

Thus, although Kedo-S Fit exhibited marginally higher mean values of flexural strength compared to Kids E Dental, the difference was not statistically significant, indicating that both materials possess comparable mechanical performance under flexural loading.

DISCUSSION

Premature loss of primary teeth frequently necessitates the use of space maintainers to preserve arch integrity and guide proper eruption of permanent successors.[15] Stainless steel preformed space maintainers have gained popularity due to their standardization, reduced chairside time, and clinical reliability.[15,16] However, their mechanical properties, particularly flexural strength, play a pivotal role in ensuring long-term success.[17,18] This study compared the flexural strength of two commercially available systems—Kedo-S Fit and Kids E Dental—to determine whether significant differences exist in their mechanical performance.

The results of this in vitro investigation demonstrated that both groups exhibited comparable flexural strength values, with Kedo-S Fit performing slightly better than Kids E Dental. The slightly higher mean values of Kedo-S Fit, however, suggest a possible mechanical advantage that may contribute to enhanced clinical longevity under repeated stress.

These findings are clinically relevant because failures in space maintainers often occur due to structural deformation or breakage under occlusal load.[19] Even though the present results showed no significant intergroup difference, the observed trend towards higher strength in Kedo-S Fit suggests that design and manufacturing precision may confer improved resistance to flexural forces.[20]

The present results align with previous studies that evaluated the mechanical properties of space maintainers and consistently highlighted stainless steel as the most reliable material.[21],[22] Nagarajan et al. reported that stainless steel appliances demonstrated superior resistance to fracture compared to fiber-reinforced composites, which were prone to early failures.[23],[24] Similarly, the longevity of space maintainers is influenced not only by material strength but also by cement retention and patient compliance.[25,26]

Subramaniam and colleagues have also underscored the advantages of prefabricated space maintainers, particularly their standardization and uniformity, which reduce variability in mechanical performance compared to custom-fabricated band and loop designs.[27] The slightly higher flexural strength of Kedo-S Fit observed in this study may be attributable to differences in alloy composition or dimensional accuracy between the two manufacturers, which is consistent with the variations reported in other comparative studies on preformed pediatric appliances.[28]

The absence of statistically significant differences suggests that both Kedo-S Fit and Kids E Dental maintainers can be confidently used in clinical practice. Their flexural strength values exceed the forces typically encountered intraorally, thereby ensuring satisfactory durability during routine mastication.[29,30] Nevertheless, in cases where higher functional demands are anticipated—for instance, in children with bruxism, deep bite, or heavy occlusal loading—the slightly greater strength of Kedo-S Fit could provide an additional margin of safety.[31]

Moreover, since space maintainers are often placed in younger children who may not adhere strictly to follow-up appointments, using appliances with marginally superior resistance may reduce the incidence of unexpected failures.[32] This not only improves treatment efficiency but also reduces the psychological and financial burden on patients and caregivers.[33]

A key strength of this study is the use of a standardized flexural testing method (Instron universal testing machine), which provides objective and reproducible data on mechanical performance. The inclusion of two widely used preformed systems enhances the applicability of the findings to clinical practice. Furthermore, the evaluation of flexural strength specifically addresses one of the most critical mechanical factors influencing space maintainer success.

Several limitations must be acknowledged. First, the study was conducted in vitro, and thus does not fully replicate the dynamic oral environment where factors such as pH fluctuations, thermal cycling, and patient-specific occlusal patterns may affect appliance performance. Second, the relatively small sample size ($n = 10$ per group) may limit the statistical power to detect subtle differences. Third, only flexural strength was assessed; other properties such as corrosion resistance, fatigue strength, and long-term retention under cyclic loading were not examined, though these also play crucial roles in clinical outcomes.

Future research should incorporate larger sample sizes and include additional parameters such as fatigue resistance, fracture toughness, and corrosion behavior under simulated oral conditions. Longitudinal in vivo clinical trials comparing survival rates, patient comfort, and failure modes between different preformed systems would further validate the present findings. Investigating the role of luting cements and

cementation techniques in conjunction with mechanical strength testing could also provide a more comprehensive understanding of the clinical performance of these appliances.

CONCLUSION

Within the limitations of this study, both Kedo-S Fit and Kids E Dental pre formed stainless steel space maintainers demonstrated satisfactory flexural strength, with no statistically significant differences between the two. The slightly higher mean values observed for Kedo-S Fit indicate a potential mechanical advantage, though both systems remain clinically reliable choices. These findings reinforce the suitability of preformed stainless steel space maintainers as effective interventions for preserving arch length in pediatric patients and highlight the importance of continued research into optimizing their mechanical and clinical performance.

CONFLICT OF INTEREST:

The authors have no conflicts of interest to declare.

FUNDING:

The research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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LEGENDS

Figure 1 showing mounting of the samples

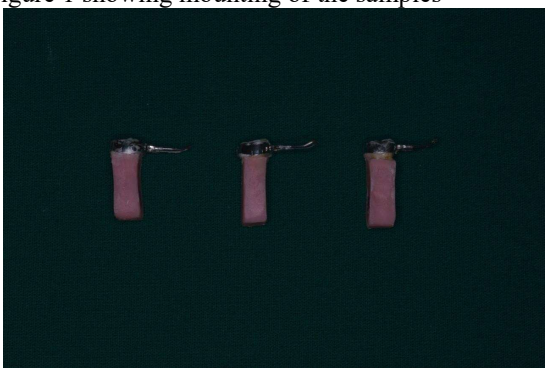

Figure 2 showing testing of flexural strength using the universal Instron machine.

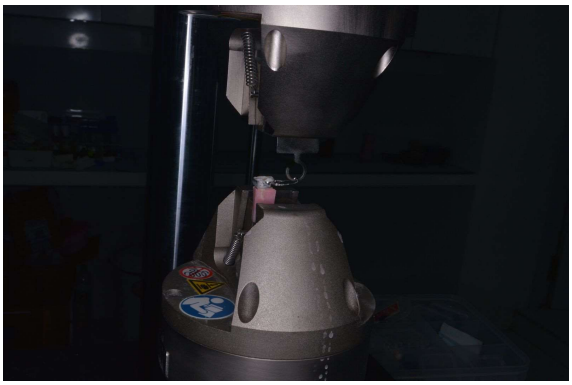

TABLE 1: Comparison of Flexural Strength of Stainless Steel Preformed Space Maintainers

Group	N	Mean Flexural Strength (N)	Standard Deviation (±SD)	95% CI Lower	95% CI Upper	t-test Value	P value
Kedo-S Fit	10	48.6	3.2	46.5	50.7	0.92	0.37
Kids E Dental	10	46.9	3.5	44.6	49.2	0.92	0.37