



Original Article

Comparative Evaluation of fracture resistance of Pediatric Composite Crowns and Stainless-Steel Crowns

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OPEN ACCESS

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Received: 28-03-2026

Accepted: 15-04-2026

Available online: 19-05-2026

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ABSTRACT

Background and Aim: Stainless steel crowns have been used successfully for full coverage restorations of primary molars due to their strength and durability. However, the poor esthetics showcased have led to introduction of new esthetic alternatives including the newly introduced composite crown. The aim of the study was to evaluate and compare the fracture resistance of composite crowns and stainless steel crowns.

Methods and Materials: The invitro study included 26 teeth in the study which were randomly divided in 2 groups of 13 teeth each. The specimens were mounted in acrylic, the teeth were prepared and crowns were cemented. Fracture resistance values were recorded using a universal testing machine.

Results: Statistical analysis was done using unpaired t test. The average values of fracture resistance for composite crowns was 629 ± 191 and for SSC was 1857.67 ± 165.81 ($p < 0.001$).

Conclusion: Although the fracture resistance of stainless steel crowns is higher than the composite crowns, they exceeded the maximum bite forces seen in children. Hence the composite crowns can be considered to be an esthetic alternative to SSCs.

Keywords: Composite crowns, Esthetics, Primary molars, Stainless steel crowns.

INTRODUCTION

Preformed metal crowns for the restoration of primary molars were first described in 1950 by Engel, followed by Humphrey.¹ Preformed stainless steel crowns are prefabricated crown forms that are adapted to individual teeth and cemented with a biocompatible agent.² These crowns have been used in pediatric dental practice for more than six decades and with very less adverse effects.

Due to an increase in the esthetic demands, there has been acceleration in the development of esthetic restorative materials. As of result of this, the practitioners as well as the patients now have choice between wide varieties of esthetic restorations. Among these, the composite resins have excellent esthetic and physical properties.³

The Edelweiss Pediatric Crowns are made up of densely filled, nanohybrid composite through a unique laser sintering and vitrification process. The manufacturer claims that the laser-sintered end product is a highly filled inorganic material with compressive strength similar to enamel and modulus of elasticity similar to dentin. Abrasion is similar to natural teeth; hence the crowns do not damage the antagonistic teeth. In addition these crowns consist of zinc nanoparticles. The mesial and distal margins of these crowns follow the natural gingival-line of the milk teeth minimizing excessive tooth reduction.⁴

While evaluating the indications of new materials it is also necessary to elucidate the properties of these materials through in-vitro testing.

Hence this study was designed to explore the fracture resistance of the newly introduced composite crowns against the stainless steel crowns on primary molars.

SUBJECTS AND METHODS

The in vitro study included 26 extracted primary molars. The sample included non-carious primary molars extracted for physiologic root resorption or orthodontic purposes and non-carious over-retained primary molars while deeply carious primary molars, restored primary molars and teeth with morphologic defects were excluded.

Procedure

Extracted primary molars were selected for evaluation of fracture resistance. Surface debridement of all these teeth was done with slurry of pumice and a prophylax cup and the teeth were stored in HBSS until the experiment. These teeth were then randomly divided into 2 groups of 13 teeth each. The teeth were separately mounted on self cure acrylic blocks. The teeth were individually prepared to receive crowns. The tooth preparation for the Composite crowns was done according to the manufacturers instructions with 1.2-1.5mm occlusal reduction, and minimal amount of circumferential reduction with a tapered preparation and a supragingival feather edged finish line. The crown was prepared for cementation by first roughening the inner surface of crown, next applying Veneer bond and light curing it for 20 seconds followed by packing it with composite. The tooth was prepared for bonding by etching tooth surface, application of bonding agent and light curing it. Finally, the crown was filled with packable composite and firmly seated on the prepared tooth surface, excess composite was removed and final curing was done from all sides. For, stainless steel crowns, occlusal reduction upto 1.5mm, minimal proximal reduction with slight occlusal convergence and 0.5- 1mm subgingival extension. Cementation was done using Type I GIC. All the specimens for assessment of fracture resistance underwent thermal cycling for 6000 cycles and were re-stored in a dry room for 24 hours before fracture loading. Fracture strength testing was performed using universal testing machine. Forces were applied axially to the center of the crown using a steel ball of 12mm diameter at a cross head speed of 1mm/min. The force was registered at the fracture moment. The value for each specimen was recorded.

Statistical Analysis

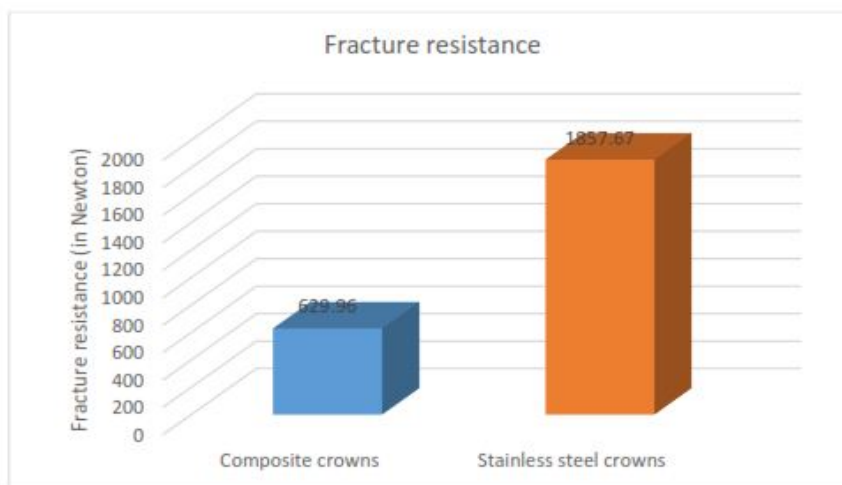
Statistical Analysis was done using unpaired t test. p value ≤ 0.05 was considered to be statistically significant.

RESULTS

The average values of fracture resistance for composite crowns was 629 ± 191 and for SSC was 1857.67 ± 165.81 ($p < 0.001$) (Table 1 and Graph 1).

Table 1: Intergroup comparison of fracture resistance (in newton) between the two test groups

Group	Number	Mean	SD	T statistic (p value)
Composite crowns	13	629.96	191.00	T= -17.501
Stainless steel crowns	13	1857.67	165.81	p = <001 **



Graph 1: Intergroup comparison of fracture resistance (in newton) between the two test groups

DISCUSSION

Dental caries is one of the most common oral diseases affecting people of every age group and one of the prime reasons for them to visit a dental clinic or a hospital. In spite of various preventive procedures and approaches available for management of the same, unfortunately the patients report at a stage when loss of at least some amount of tooth structure has already taken place.⁵

Preformed metal crowns for the restoration of primary molars were first described in 1950 by Engel, followed by Humphrey. Preformed stainless steel crowns are prefabricated crown form that are adapted to individual teeth and cemented with a biocompatible agent.³ These crowns have been used in pediatric dental practice for more than six decades and with very less adverse effects.⁶ These crowns have been indicated for restorations of primary and permanent teeth with extensive caries, cervical decalcification, and/or developmental defects, following pulpotomy or pulpectomy, for restoring a primary tooth that is to be used as an abutment for a space maintainer, for the intermediate restoration of fractured teeth, and for definitive restorative treatment for high caries-risk children.⁷

Due to an increase in the esthetic demands, there has been acceleration in the development of esthetic restorative materials. As a result of this, the practitioners as well as the patients now have choice between wide varieties of esthetic restorations. Among these, the composite resins have excellent esthetic and physical properties.¹

Dental resin based composites are structures composed of three major components: a highly cross linked polymeric matrix reinforced by a dispersion of glass, mineral, or resin filler particles and/or short fibres bound to the matrix by coupling agents. A key advantage of resin materials is that they can be made in a range of consistencies, from highly fluid to rigid pastes, which allows them to be conveniently manipulated and molded, to a custom made form and then converted through a polymerization curing reaction to a hard, strong, attractive, and durable solid.²

The Edelweiss Pediatric Crowns are made up of densely filled, nanohybrid composite through a unique laser sintering and vitrification process. The manufacturer claims that the laser-sintered end product is an highly filled inorganic material with compressive strength similar to enamel and modulus of elasticity similar to dentin. Abrasion is similar to natural teeth; hence the crowns do not damage the antagonistic teeth. In addition these crowns consist of zinc nanoparticles. The mesial and distal margins of these crowns follow the natural gingival-line of the milk teeth minimizing excessive tooth reduction.³

Fracture resistance is one of the important criteria defining long term success. This feature is dependent on the elastic modulus of the supporting substructure, properties of luting agents, tooth preparation design, surface roughness, residual stress and restoration thickness.⁸

The average values of fracture resistance recorded for composite crowns was 629 ± 191 , while the average values for stainless steel crowns was 1857.67 ± 165.81 . The difference between the two groups was seen to be highly significant. Braun et al. found the mean maximum bite force in 6 to 8 year olds was 78 N and up to 106 N for 10 to 12 year olds in the primary first molar region. Utilizing a different methodology, Gavião et al. found the mean bite force of 235.12 N in a sample of three- to six-year-olds.⁹ Even with this increased estimate, the mean force to fracture the crowns in this study exceed these values. Thus, even though a statistically significant difference was found between the two types of crowns, the clinical significance of the values has to be determined. Another observation that was seen during the study was that, in case of composite crowns, only the fracture of the crown was seen as opposed to the stainless steel crown group where the fracture was seen to be catastrophic to the tooth causing the fracture of the crown as well as the tooth.

Various studies by Townsend et al⁹, Akila et al¹⁰, evaluating the fracture resistance of veneered stainless steel crowns and prefabricated zirconia crowns which showed values similar to the ones obtained in our study for stainless steel crowns. A study by Beattie et al¹¹ showed mean value for the stainless steel crowns $1,671 \pm 370$ N. Our study is the first to evaluate the fracture resistance of the newly introduced composite crowns. The strength of the present study is that it is the first study of its kind to evaluate the physical properties of the newly introduced Edelweiss Pediatric Composite crowns.

CONCLUSION

Based on the limitations of the study it can be concluded that on assessment of fracture resistance between the two groups, the difference between the two groups was seen to be highly significant with stainless steel crowns having greater fracture resistance as compared to that of the composite crowns. However, the fracture resistance of both the crowns exceeded the maximum bite forces seen in children, hence the composite crowns can be considered to be an esthetic alternative to SSCs

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