Effect of Incisal Height on Anterior Zirconia Crown Retention of Primary Maxillary Central Incisors

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INTRODUCTION

Pediatric zirconia crowns are prefabricated full coverage crowns and rely upon the skill and technique of the pediatric dentist to prepare the primary tooth appropriately. Moreover, zirconia crowns cannot be crimped, and the clinician must prepare the teeth to fit the zirconia crowns.[1-4] Multiple factors affect the retention of crowns, including taper, height (either occluso-cervical or inciso-cervical), width, and the type of luting agent. Also, marginal and internal adaptation are critical factors when discussing the stability of prefabricated zirconia crowns.[5-10] Unfortunately, with primary teeth, prefabricated zirconia crowns do not possess a custom fit to the preparation, and many preparations may be excessive due to caries removal, trauma/fracture, or even overpreparation to achieve the desired passive fit. Since primary maxillary incisors erupt before the age of one and exfoliate around the age of seven, there is an aspiration concern as well as an esthetic concern if a recently cemented anterior zirconia crown becomes dislodged and lost. This study aims to determine if anterior incisor inciso-cervical preparation height impacts the overall retention of a cemented prefabricated zirconia crown. These results may provide a pediatric dentist with additional information to apply and consider when creating treatment plans to restore primary anterior incisors.

OBJECTIVE

The aim of this study was to test the effects of incisal height of primary maxillary incisors on the retention of anterior prefabricated zirconia crowns.

METHODS

IRB status of exempt (IBC #4997) was granted for this study by the Louisiana State University Health Science Center, New Orleans, Louisiana, USA on February 15, 2023. Sixty primary maxillary central incisors were designed and printed. These preparations were designed using NuSmile® size 2 zirconia crown manufactured for a right maxillary central incisor. This crown was scanned, and a negative was created using Fusion 360. The overall preparation was designed to passively and properly adapt to the intaglio of each zirconia crown with the only deficiency found in the various incisal heights. When measured from the incisal edge of preparation to the facial cervical margin of the zirconia crown, the preparation inciso-cervical heights 5.00 mm, 4.25 mm, 3.50 mm, 2.75 mm, 2.00 mm, and 1.25 mm were placed into groups of ten. 3M RelyX™ Luting Plus Automix was used per the manufacturer's instructions to cement the NuSmile® crowns. After cementation, all cemented crown preparations were placed in a 37-degree Celsius incubator for 24 hours to mimic the oral environment and ensure a complete set of cement. Pull-off tests using the Instron 5566 were completed. The force (N) at dislodgment along with the stress of removal (MPa) was calculated by using the surface area of each preparation and recorded in Microsoft Excel. Statistical analysis using Pairwise Wilcoxon rank-sum tests was used to compare the force and megapascals among inciso-cervical height groups. Additionally, linear regression was used to examine whether an increase in inciso-cervical height was associated with an increase in force or tensile stress.

RESULTS

Pairwise Correlation P-values for Force and Tensile Stress at each Inciso-cervical height

	Pairwise p-values for force at each inciso-cervical height				
Height:	2.00 mm	2.75 mm	3.50 mm	4.25 mm	5.00 mm
1.25 mm	0.529	**0.004**	**<0.001**	**<0.001**	**<0.001**
2.00 mm		**0.011**	**<0.001**	**<0.001**	**<0.001**
2.75 mm			**<0.001**	**<0.001**	**<0.001**
3.50 mm				0.218	**0.003**
4.25 mm					**0.011**

	Pairwise p-values for tensile stress at each inciso-cervical height				
Height:	2.00 mm	2.75 mm	3.50 mm	4.25 mm	5.00 mm
1.25 mm	0.739	**0.023**	**<0.001**	**<0.001**	**<0.001**
2.00 mm		**0.043**	**<0.001**	**<0.001**	**<0.001**
2.75 mm			**<0.001**	**<0.001**	**<0.001**
3.50 mm				0.529	0.052
4.25 mm					**0.043**

Table 1a and 1b: Pairwise correlation p-values for force and tensile strength at each inciso-cervical height. Bold text shows p-values < 0.05.

Tensile Stress at Break by Group

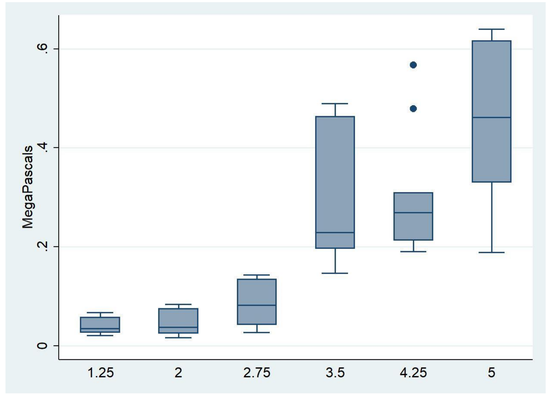
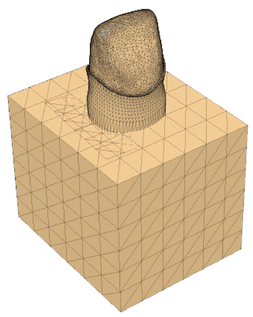


Figure 1. Tensile Stress at Break by Group

Photo of Created STL



Representative photographic picture showing an STL 5.00 mm preparation scanned and imported into Fusion 360.

Maximum Load at Break by Group

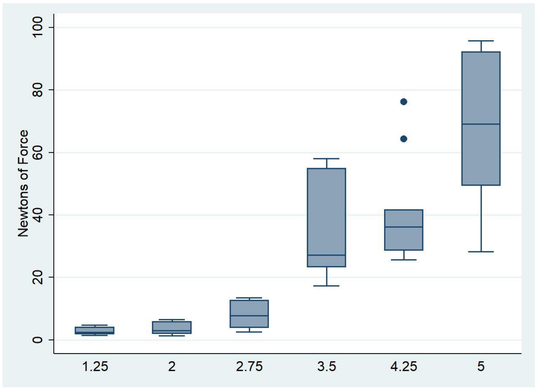
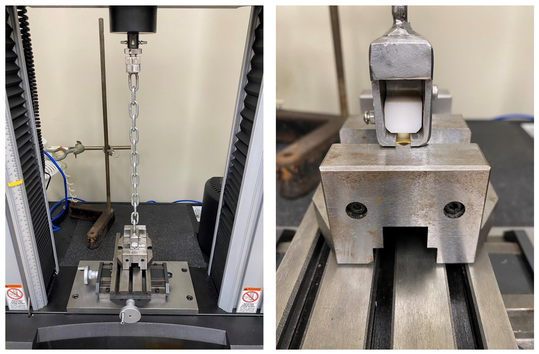


Figure 2. Maximum Load at Break by Group

Photo of Testing Mechanism



Representative photographic pictures showing the testing of retention strength with the Instron 5566.

CONCLUSIONS

1. An increase in inciso-cervical height was associated with increased retention, as measured by both the force and tensile stress required to dislodge prefabricated anterior zirconia crowns.
2. Practitioners should consider increased inciso-cervical heights when restoring primary anterior teeth with prefabricated zirconia crowns.

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