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Research Article

The Effects of Rubber Dam Clamps on Zirconia Crown Restorations

Haley D. Kessler, DDS[1]*, Albert F. McMullen III DDS, FACD[2], Hunter Kortum B.S[3], Edwin Kee MCDT[4], Thomas Lallier PhD[5]

[1]Department of Endodontics, Louisiana State University Health Sciences Center (LSUHSC), USA.

[2]Department Head and Postgraduate Director, Endodontics, Louisiana State University Health Sciences Center (LSUHSC), USA.

[3]Louisiana State University Health Sciences Center (LSUHSC), USA.

[4]Professor, Prosthodontics, Louisiana State University Health Sciences Center (LSUHSC), USA.

[5]Professor, Cell Biology and Anatomy Coordinator for Student Research, Louisiana State University Health Sciences Center (LSUHSC), USA.

***Corresponding Author**: Haley D. Kessler, DDS, Department of Endodontics, Louisiana State University School of Dentistry, New Orleans, LA, USA.

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Abstract

Rubber dam isolation is crucial in providing sterility and a controlled environment when performing root canal therapy. Rubber dam clamps have been controversial due to their rigidity and composition, which is thought to cause damage to zirconia full coverage crowns. This study evaluated three types of zirconia crowns anterior 5Y, premolar 4Y, and molar 3Y to assess their resistance to damage from rubber dam clamps. Of the 30 total zirconia crowns that were tested for damage following the usage of rubber dam clamps, no fractures or chips were observed. There was no significant difference between the negative control group, and the experimental groups, showing that the post-test zirconia crowns demonstrated no measurable damage when examined under an endodontic microscope. The findings of this study suggest that rubber dam clamps pose no threat to the integrity of zirconia full coverage restorations, but more studies should be done in the future to determine the long-term prognosis of these crowns after repeated rubber dam clamp usage as well as to determine any change in chemical structure of these crowns after rubber dam clamp use.

Keywords: *Zirconia Crowns; Rubber Dam Clamps; Restorative Integrity; Endodontic Isolation*

Introduction

Rubber dam isolation is considered a critical component of endodontic procedures, providing a sterile and controlled environment while preventing contamination of the root canal system. The American Association of Endodontists (AAE) recognizes rubber dam isolation as a standard of care for endodontic treatments. However, concerns exist regarding the potential for rubber dam clamps (RDC) to cause damage to restorative materials, especially those that are more fragile, such as porcelain or resin-based materials. Zirconia crowns, known for their strength, biocompatibility, and esthetic qualities, have become a preferred choice for full coverage restorations. While zirconia is a durable material, its response to mechanical stress caused by the pressure applied by rubber dam clamps has not been thoroughly examined. Previous studies on the effects of rubber dam clamps have focused primarily on porcelain-fused-to-metal (PFM) crowns, which have shown susceptibility to damage. However, no published studies address the specific effects of rubber dam clamps on zirconia crowns, leading to a significant gap in the literature. This study aims to investigate the impact of rubber dam clamps on zirconia crowns by analyzing whether the application of these clamps leads to any detectable damage, such as fractures or chips, in anterior (5Y) and posterior (4Y and 3Y) zirconia restorations. (1-12)

Materials and Methods

Study Design and Groups: The study involved three experimental groups, each representing a different tooth type and zirconia formulation. Each group underwent the same procedure, with the only differences being the type of zirconia material used (5Y for anterior, 4Y for the premolar group, 3Y for posterior) and the type of rubber dam clamp applied.

Group 1: Maxillary right central incisor, 10 samples of high translucency 5Y zirconia crowns (anterior).

Group 2: Mandibular right first premolar, 10 samples of 4Y zirconia crowns (premolar).

Group 3: Mandibular right first molar (Tooth #30), 10 samples of 3Y zirconia crowns (molar).

Crown Preparation and Fabrication: Typodont teeth were prepared to meet the ADEX (CDCA/WREB/CITA) standard for an all-ceramic crown. Digital impressions of the prepared teeth were taken using the Prime Scan intraoral scanner. CAD/CAM technology was then used to design and mill 10 crowns and 10 dies for each group (30 crowns and 30 dies total). Each crown was finished using a standardized set of zirconia finishing wheels. Crowns were cemented onto PMMA dies using Rely X Luting Plus dual-cure cement.

Control Evaluation: Before rubber dam clamps were applied, each crown was evaluated under a Zumax dental operating microscope to detect any baseline damage. Photographs of each crown were taken to document their condition. This pre-clamp evaluation served as a negative control. At the conclusion of the experiment, crowns were fractured on purpose to ensure that fractures were detectable.

Rubber Dam Clamp Application:

Group 1 (Anterior): Size 212 butterfly clamp was used.

Group 2 (Premolar): Size 2a clamp was used.

Group 3 (Molar): Size 14a clamp was used.

Each clamp was placed onto the appropriate crown for one hour and then removed. After removal, the crowns were re-examined using the dental operating microscope to inspect for any damage.

Damage Evaluation

After the rubber dam clamp was removed, the crowns were carefully examined for fractures, chips, or other forms of damage. The crowns were photographed and any fractures were measured using ImageJ software to the nearest 0.1mm. To ensure all damage was detected, the crowns were then scrubbed with methylene blue dye and re-inspected under the microscope.

Results

A total of 30 zirconia crowns (10 from each group) were tested for damage following the application of rubber dam clamps. None of the crowns exhibited detectable damage, such as fractures or chips, following the application and removal of the rubber dam clamps.

Negative control: No fractures or chips were observed in any of the crowns.

Positive control: All positive controls were fractured. Hemostats were used to fracture the anterior crown. Surgical forceps were used to fracture the premolar crown. The molar required a chisel and hammer to fracture.

Group 1 (5Y anterior crowns): No fractures or chips were observed in any of the crowns.

Group 2 (4Y premolar crowns): Similarly, no fractures or chips were noted in any of the crowns.

Group 3 (3Y molar crowns): No damage was observed in any of the crowns in this group.

There was no significant difference between sets of data for the negative control group and groups 1, 2, and 3. Thus, the teeth before RDC appeared to be the same as after RDC. Using a Chi squared analysis looking at the presence or absence of crack and Student's T-Test (2-tailed) there was no significant difference ($P>0.05$).

In each group after the clamps were applied, the crowns appeared intact, and no significant deviation in structure or integrity were observed when examined under the dental microscope. Methylene blue staining did not reveal any undetected damage. These results suggest that rubber dam clamps, when applied under standard conditions, do not cause damage to zirconia crowns

Figure 1. *Rubber Dam Clamps on Crowns.* ***A:*** *Anterior 5Y zirconia crown cemented to die with RDC in place* ***B:*** *Premolar 4Y zirconia crown cemented to die with RDC in place.* ***C:*** *Molar 3Y zirconia crown cemented to die with RDC in place.*

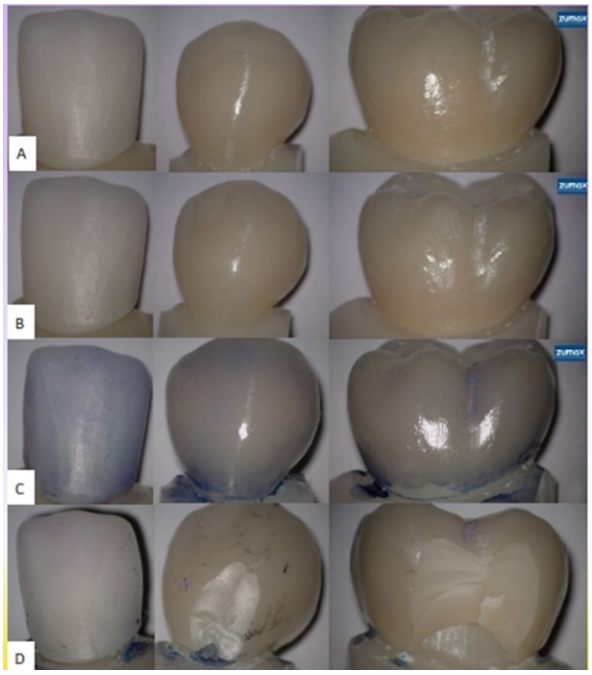

Figure 2. *Zirconia Crown Damage Evaluation.* ***A:*** *Anterior, premolar, and molar crowns before RDC placement.* ***B:*** *Anterior, premolar, and molar crowns after RDC placement.* ***C:*** *Anterior, premolar, and molar crowns after RDC placement with methylene blue dye.* ***D:*** *Positive control fractured crowns*

Discussion

The results demonstrated no detectable damage to any of the formulations of zirconia full coverage restorations. These results provide reassurance to the usage of rubber dam clamps on zirconia crowns to provide a sterile and controlled working environment in a clinical setting. A limitation of this study is that it only provides insight to first time use of a rubber dam clamp placed on a new zirconia crown without any clinical variables, such as wet/dry environments or the lifetime of the crown. Without clinical variables, this study lends its way to needing future studies done to gain full knowledge of the safety and viability of rubber dam clamp usage without the need of specific isolation modifications. Due to there being no current studies examining the effects of rubber dam clamp usage on zirconia crowns, there should be follow up studies done in the future to further demonstrate the safety of rubber dam clamp usage on zirconia crowns, or to examine possible damage in long-term studies or at the molecular level. (1-12)

Conclusion

The findings of this study suggest that rubber dam clamps do not pose a significant risk of causing fractures or chips in zirconia crowns, regardless of the formulation used (5Y for anterior, 4Y or 3Y for posterior restorations). These results provide clinical reassurance for the continued use of rubber dam isolation in the presence of zirconia restorations, especially during endodontic procedures. The strength and durability of zirconia appear to make it resistant to the mechanical forces applied by rubber dam clamps, which is an important consideration for practitioners in ensuring the long-term success of zirconia restorations.

Conflict of Interest

The authors declare no conflict of interest.

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