Artifacts Generated by Pediatric Stainless Steel and Zirconia Crowns on CBCT Imaging: An In Vitro Study

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Introduction

- Pediatric patients with hematologic, oncologic, or orthopedic concerns require frequent 3D imaging for medical purposes; MRI and CT are standard forms of 3D imaging, cone beam computed tomography (CBCT) is becoming more popular[1,2]
- Physicians often request placement or removal of specific dental materials to reduce beam hardening effects that result in distortion of the 3D imaging[3-5, 6,7]
- Stainless steel crowns (SSCs) are recommended in children with extensive carious lesions and/or are classified as high caries risk[8]; however, metals are known to produce artifacts in both MRI and CT/CBCT images[4,5,7,9-13]
- Preformed zirconia crowns (PZCs) are often requested in pediatric dentistry in an effort to reduce distortion of the image; however, previous research on zirconia implants were shown to produce artifact, consistent with its high atomic number and radiopaque appearance[3,9,12]

Purpose

- The aim of this study is to examine the production of artifacts on CBCT images produced by SSCs and PZCs; it is hypothesized that PZCs will generate significantly greater artifact than SSCs on CBCT imaging

Methods

- 36 previously extracted primary first and second molars were collected during daily clinical operations at UNMC Pediatric Dentistry
- UNMC IRB: approval not necessary citing use of routine medical waste
- Three independent variables: control of non-restored teeth (n=12), teeth restored with 3M ESPE SSCs (n=12), teeth restored with NuSmile PZCs (n=12)
  - Power analysis: estimates a sample size of 12 for each variable will yield a power of 89%
- All samples mounted in dental stone with wax support to simulate density of surrounding hard and soft tissue (Figure 1)
- Mounted teeth scanned using the Planmeca CBCT small scale mounting plate (Field of View: 4.0cm x 5.0cm)
  - Settings: 90kV, 8mA, 12 sec, Artifact Removal Algorithm: None
  - Scans analyzed with Planmeca Romexis software, visual appearance of artifact was converted to data, via grayscale values, for statistical analysis
  - Axial projection: consistent slice of image chosen mid-distance from the occlusal surface to the CEJ
  - 8 circumferential points plotted 1mm from edge of the tooth, a 1mm^3 box created at each point, Romexis software identifies a grayscale value for each box (Figure 2)
  - Grayscale values range from -1000 (radiolucent) to +1000 or greater (radiopaque)

Figure 1

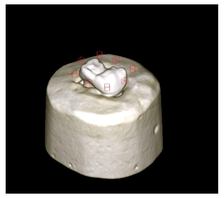


Figure 2

Results

- Average grayscale values for each variable are depicted in the box-and-whisker plot below
- Table 1 demonstrates descriptive statistics, including medians and interquartile ranges representing the middle 50% of the data
- A Kruskal-Wallis test (p-value < 0.0001), indicates the average amount of grayscale significantly differed between the three crown types
- Post-hoc pairwise comparisons using Wilcoxon Rank Sum Tests, with Bonferroni adjusted p-values indicates the average grayscale values in all groups significantly differ from each other (p < 0.05*)
  - Control vs. SSC: p-value = 0.0088*
  - Control vs. PZC: p-value = 0.0001*
  - SSC vs. PZC: p-value = 0.0001*

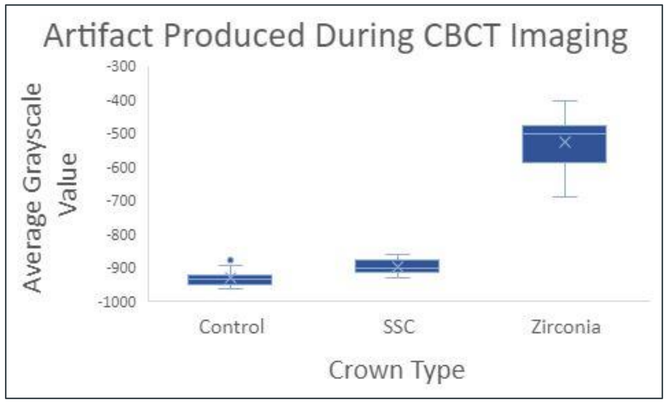
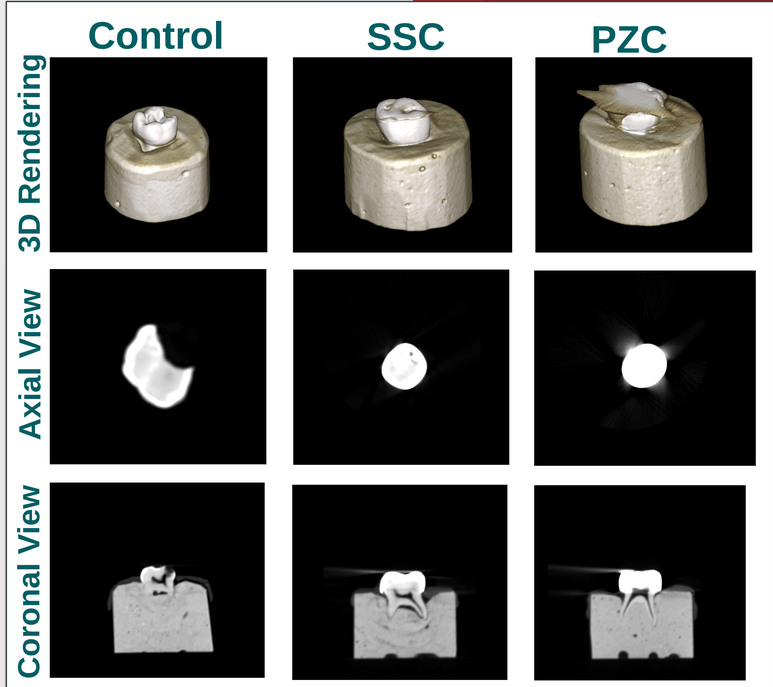


Table 1: Descriptive Statistics

Variable	Median	25%	75%	Minimum	Maximum
Control	-932.63	-949.79	-922.78	-964.94	-878.34
SSCs	-902.23	-914.30	-878.29	-932.33	-860.07
PZCs	-501.42	-571.58	-480.72	-688.22	-401.87



Conclusion

- PZCs generated significantly greater artifact than SSCs
- Results of this study are impactful, indicating that PZCs may not be an acceptable alternative to SSCs for patients undergoing frequent 3D medical imaging due to the significant amount of artifact PZCs produced
- In vivo studies are needed to confidently apply findings to clinical decision making and discussion with interprofessional providers
- Further research should include analyzing artifact generated from PZCs and SSCs during MRI and CT imaging

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