CBCT Imaging Artifact Generated by Stainless Steel and Zirconia Crowns

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Background

- For pediatric patients with hematologic, oncologic, or orthopedic concerns, frequent three-dimensional imaging (e.g., MRI, CT, CBCT) is essential to monitor disease progression and guide treatment planning[1-2]
- These images may be affected by various materials, including those commonly used in restorative pediatric dentistry (e.g., stainless steel and zirconia)[3-5]
- Stainless steel crowns (SSCs) and preformed zirconia crowns (PZCs) are often used in children classified as high caries risk or with extensive carious lesions[6]
- Both SSCs and PZCs have the potential to generate artifacts (i.e., distortions on medical imaging), oftentimes prompting physicians to request the pediatric dentist use, or refrain from using, one of these materials[4-5, 7-13]

Purpose

- The aim of our research was to examine the production of artifacts on CBCT images caused by SSCs and PZCs
- We hypothesized that PZCs would generate significantly greater artifact on CBCT images compared to SSCs

Methods

- Sample of 36 previously extracted primary molars — 12 non-restored control teeth, 12 3M ESPE SSCs, and 12 NuSmile PZCs
- Each tooth was mounted individually in dental stone with wax support to simulate hard and soft tissue (see Figure 1)
- A Planmeca ProMax 3D Classic CBCT machine was used to scan each mounted tooth with a 4.0 x 5.0 cm FOV at 90 kV, 8.0 mA, and 12 seconds without artifact reduction algorithm selected
- Planemca Romexis software was used to measure grayscale values in 1 mm³ regions of interest at 8 locations around each sample (see Figure 2)
- Locations were selected at the midpoint between the CEJ and occlusal surface and placed 1 mm from B, L, M, D, MB, DB, ML, and DL surfaces
- Average grayscale values, with possible values ranging from -1000 (black) to +1000 (white), were used to assess amount of artifact generated by each sample

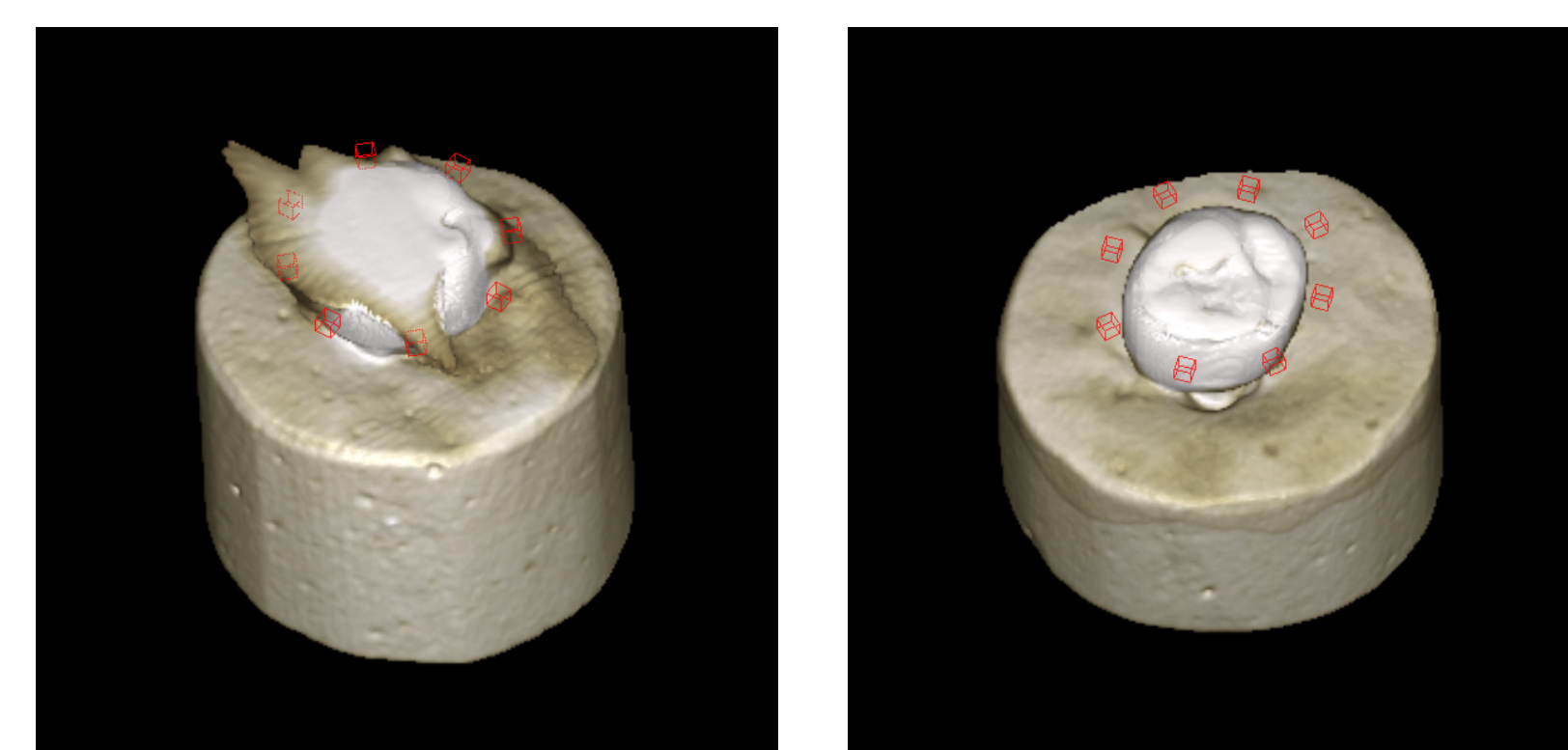Figure 1. SSC mounted in dental stone with wax support.

Figure 2. Regions of interest located around PZC (left) and SSC (right).

Results

- See Table 1 for descriptive statistics, including medians, interquartile ranges, minimums, and maximums; see Graph 1 for visual representation of data
- A Kruskal-Wallis test revealed a significant difference in average grayscale values across the three groups, p < 0.0001
- Post-hoc pairwise comparisons using Wilcoxon Rank Sum tests with Bonferroni adjusted p-values were used to analyze differences between groups
- Both SSCs and PZCs generated significantly greater artifact compared to control teeth, p = 0.01 and p = 0.0001, respectively
- PZCs generated significantly greater artifact compared to SSCs, p = 0.0001

Table 1. Descriptive statistics. Average grayscale values shown.

	Median	25th Pct.	75th Pct.	Min.	Max.
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
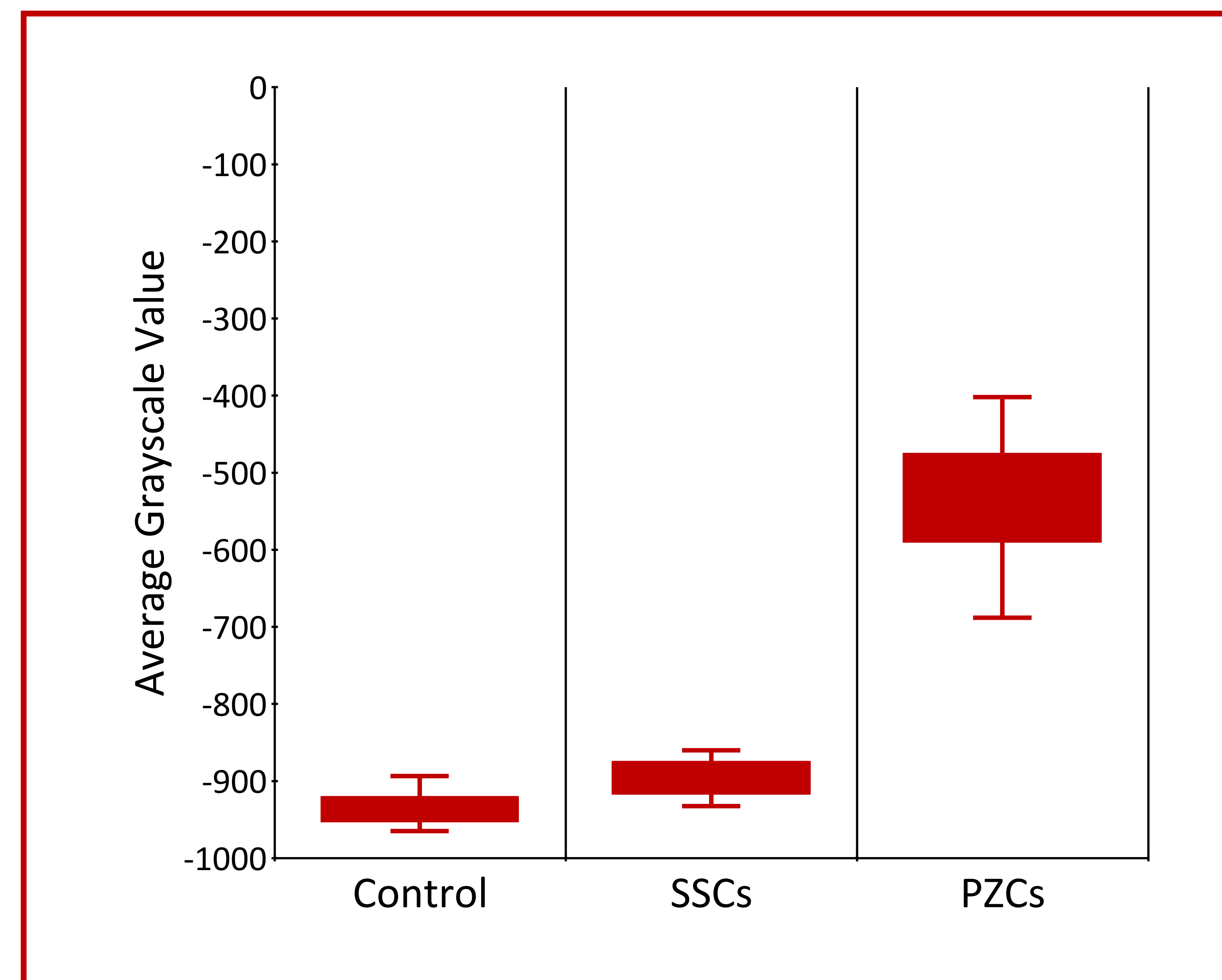
Graph 1. Greater artifact is noted as average grayscale values become more positive. PZCs exhibited the most positive average grayscale values, thus generating the greatest artifact.

Figure 3. Control teeth. Axial view (left), sagittal view (middle), and 3D rendering (right).
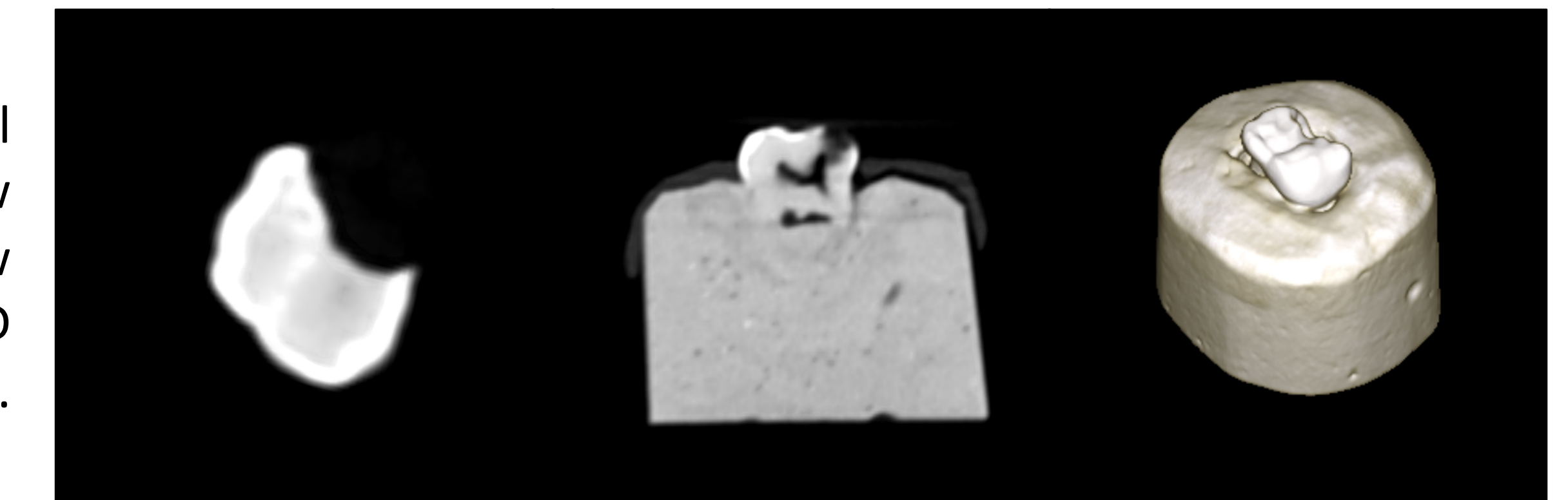

Figure 4. SSC; note limited artifact. Axial view (left), sagittal view (middle), and 3D rendering (right).
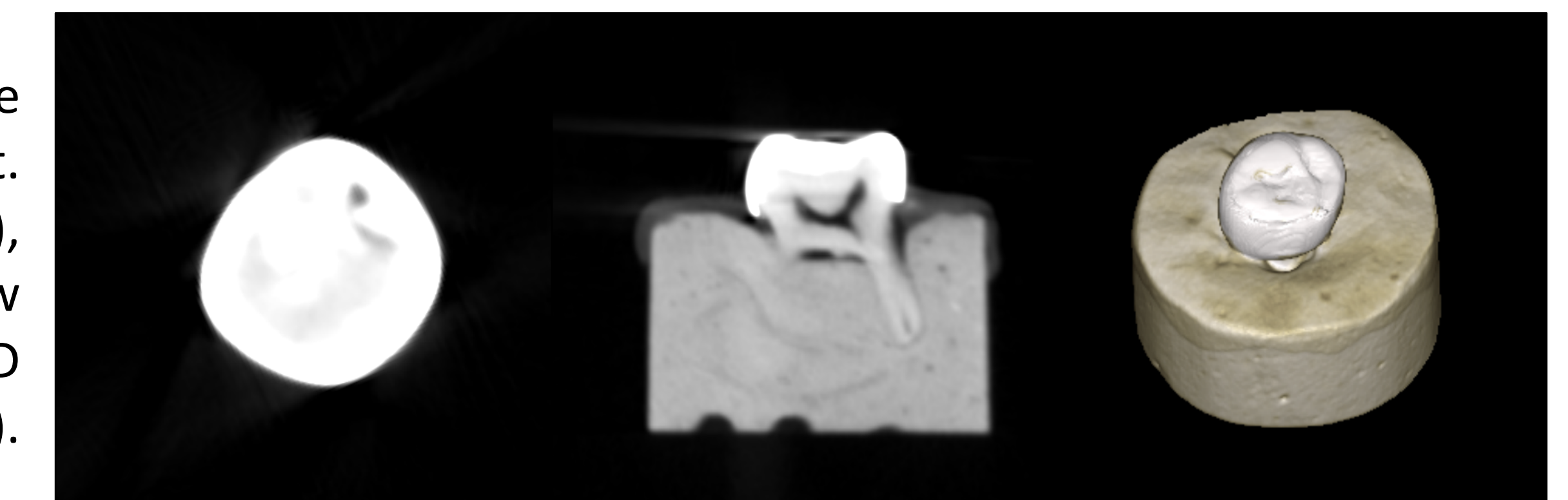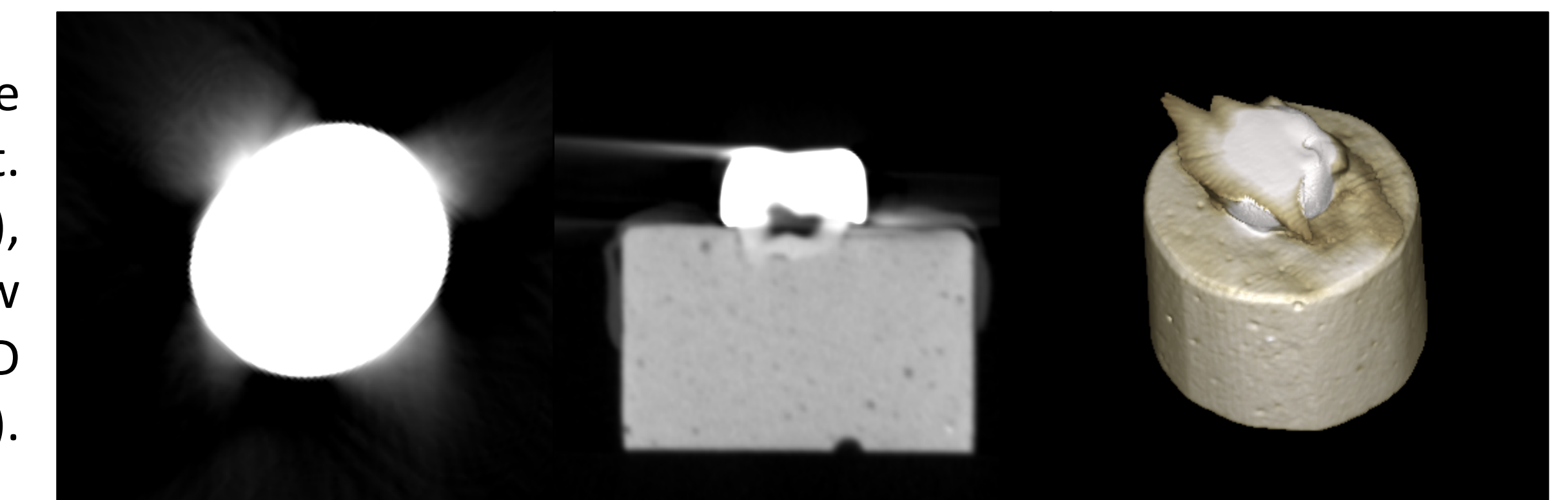

Figure 5. PZC; note significant artifact. Axial view (left), sagittal view (middle), and 3D rendering (right).

Conclusion

- PZCs generate significantly greater artifact on CBCT imaging compared to SSCs
- For patients undergoing frequent three-dimensional imaging, specifically CBCT imaging, PZCs may not be an acceptable alternative to SSCs
- Further research is needed to determine the effect in vivo and whether results remain across other three-dimensional imaging modalities (i.e., MRI, CT)

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