



# Influence of Implant Abutment Designs on Cement Extrusion for Cement-Retained Implant Restorations: An In-Vitro Study

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## INTRODUCTION

Implant-supported restorations have revolutionized dentistry, with **screw-retained** and **cement-retained restorations** being the primary approaches.<sup>1,2</sup> Cement-retained restorations offer esthetic advantages by eliminating screw access holes and providing a passive fit that compensates for minor implant placement discrepancies. The cement layer can also absorb occlusal forces, reducing stress on implants and tissues.<sup>3,4</sup>

However, **excess cement extrusion** at the crown-abutment margin can harm periodontal tissues, triggering inflammation, bone loss, and implant failure.<sup>5-9</sup> Proper cement removal and peri-implant management are crucial to prevent these complications.<sup>10</sup> Venting techniques and improved cementation methods reduce cement extrusion, enhance crown seating, and improve outcomes.<sup>11-16</sup>

The **rheological properties** of dental cements, such as viscosity and shear-thinning behavior, significantly influence handling and adaptation.<sup>20-25</sup> Factors like temperature, particle size, and additives further affect performance, with advances aiming to optimize restoration success.

## AIM OF THE STUDY

The purpose of this in-vitro study is to compare the effect of implant abutment design modification on the amount of cement extruded at the crown-abutment margin using CAD/CAM replicas.

## RESEARCH QUESTION

**"How do implant abutment design modifications influence the amount of cement extruded at the crown-abutment margin in CAD/CAM replicas?"**

## MATERIAL AND METHODS

Seventy-five 3D-printed abutments (TOC: 4°, height: 7 mm) and copings were designed using TinkerCAD and printed with Elegoo ABS resin on an Elegoo Saturn printer. The abutments were divided into five groups (n=15 per group): (1) **CLA**: closed abutment with the screw access channel filled with resin; (2) **OA**: open abutment; (3) **IVA**: open abutment with two 1.5-mm vent holes placed 3 mm apical to the occlusal edge; (4) **COA**: cone abutment; (5) **IVCA**: internal vented cone abutment. (Fig. 1 & 2)

To aid in coping orientation, four 5-mm vertical marks (midfacial, lingual, and proximal surfaces) were applied. (Fig. 3) TempBond NE cement was mixed per manufacturer instructions, loaded into the copings, and seated onto the abutments under 5 kg of force for 10 minutes using a calibrated spring compression device. (Fig. 4 & 5)

Weights were recorded using a Sartorius Electronic Analytical Balance at three stages: before cementation (Coping Abutment Assembly **CAA**), after setting (pre-cement removal), and after cleaning (post-cement removal). The amount of cement-retained in the abutment was calculated by subtracting the initial abutment weight (CAA weight) from the post-cement removal weight. The total cement loaded into the coping was calculated by subtracting the initial abutment (CAA) weight from the pre-cement removal weight. The percentage of extruded cement was determined accordingly.

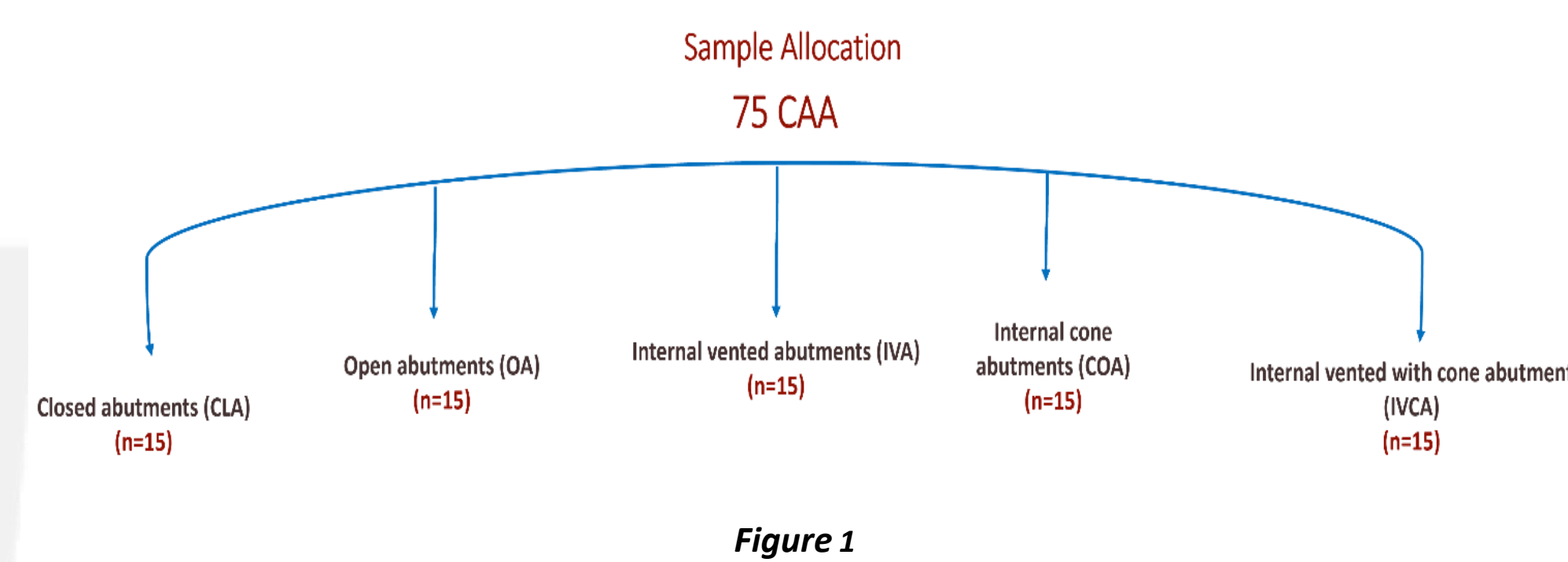


Figure 1



Figure 3

Figure 4

Figure 5

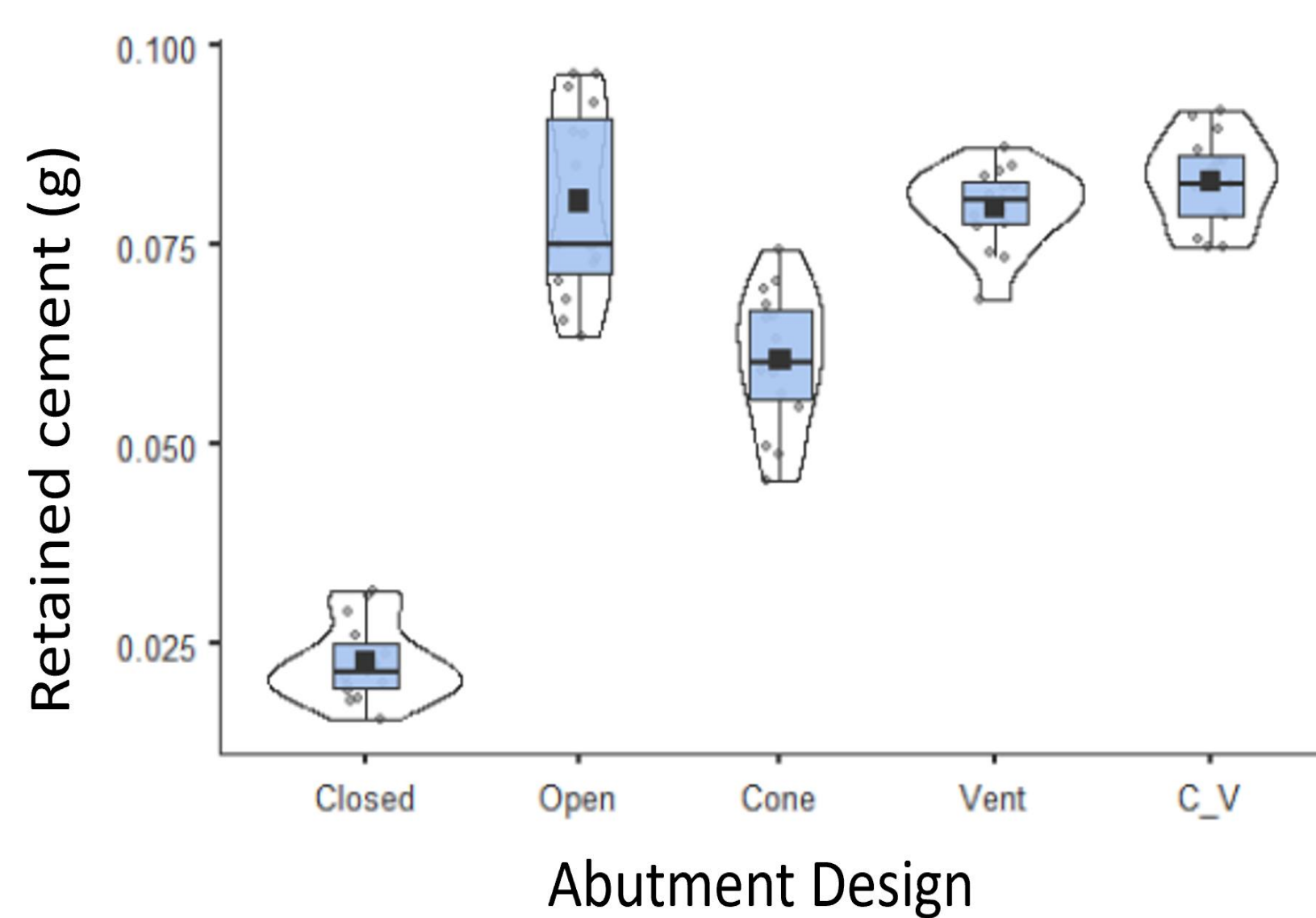


Figure 6

## RESULTS

The amount of excess cement extruded at the abutment-crown margin was greatest for the closed abutment and least for the internal vent with cone abutment ; ( $IVCA < OA < IVA < COA < CLA$ ), each one was statistically significantly different ( $P < 0.05$ ). (Fig.6)

## DISCUSSION

The results from this study reveal that implant abutment design significantly affects the amount of cement extruded at the crown-abutment margin. The closed abutment (CLA) had the most cement extrusion due to the occluded screw access channel, while the internal vent with cone abutment (IVCA) had the least, likely due to the combination of vent holes and cone shape, which improved cement flow within the CAA. The open abutment (OA) and internal vented abutment (IVA) showed moderate cement extrusion, with IVA performing better due to venting. The cone abutment (COA) also exhibited moderate extrusion but was less effective than IVCA.

These results align with previous studies highlighting that abutment modifications, such as venting or cone shapes, help reduce excess cement, with significant differences ( $P < 0.05$ ) observed between groups.

## CLINICAL IMPLICATIONS

- **Modifying implant abutment designs, such as incorporating venting or cone features, may reduce the amount of cement extruded at the crown-abutment margin.**
- **Adjusting implant abutment designs for better cement flow management could be a valuable strategy for improving patient outcomes and minimizing the risk of complications related to excess cement.**

## LIMITATIONS

The limitations of this study include: it was an in-vitro study using 3D-printed replicas, which may not fully replicate the clinical conditions of natural tooth and implant interfaces. Additionally, only one type of cement was evaluated, which may limit the generalizability of the findings to other cement materials. Future studies could explore the effect of other abutment materials and additional modifications, such as variations in the size and placement of vent holes, as well as the use of different cements, to further optimize the management of cement flow.

## CONCLUSIONS

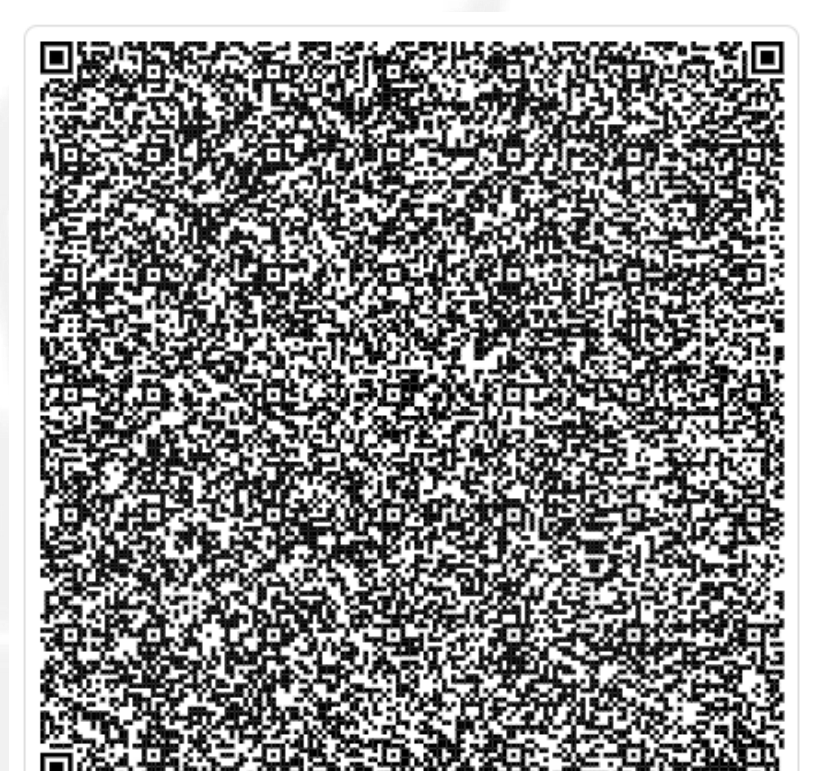
Within the limitation of this in-vitro study the following conclusions are made:

- Modifying the abutment design significantly affects the cement that remains within the abutment.
- Incorporating a vent, cone or both into the abutment design significantly reduces the amount of extruded cement.

## Acknowledgment

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## REFERENCES



**The Null Hypothesis Was Rejected**