

A Biomechanical Analysis of The Retentive Efficacy of A Partially Customized Abutment Specifically Designed for Single Implant Application in the Esthetic Zone

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Background

Due to the non-congruent nature of the implant and crown axis in the esthetic zone the retentive strength of a cemented crown supported by a custom-milled abutment have been generalized from tapered abutment studies based on completely different morphological profiles.

Purpose of study

The purpose of this study is to compare the factors of taper, length, angle and number of vertical axial walls that affect the retentive strength of a cemented crown on a partially customized hybrid abutment in the esthetic zone.

Materials and Method

A total of 35 metal copings were used in this study divided into one group with 30 copings cemented to their corresponding 8° tapered abutment with lengths from 3 to 8 mm with 1 mm increments (Fig 1A, B). The remaining five consisted of a standardized metal coping matching the hexagonal abutment with 3 mm vertical axial walls and the sequential removal of 1, 2, and 3 contiguous vertical axial walls (Fig 2A, B). Dislodgment tests were performed for all copings in both groups. Maximum retentive forces were measured in kgF (Fig 3A, B).

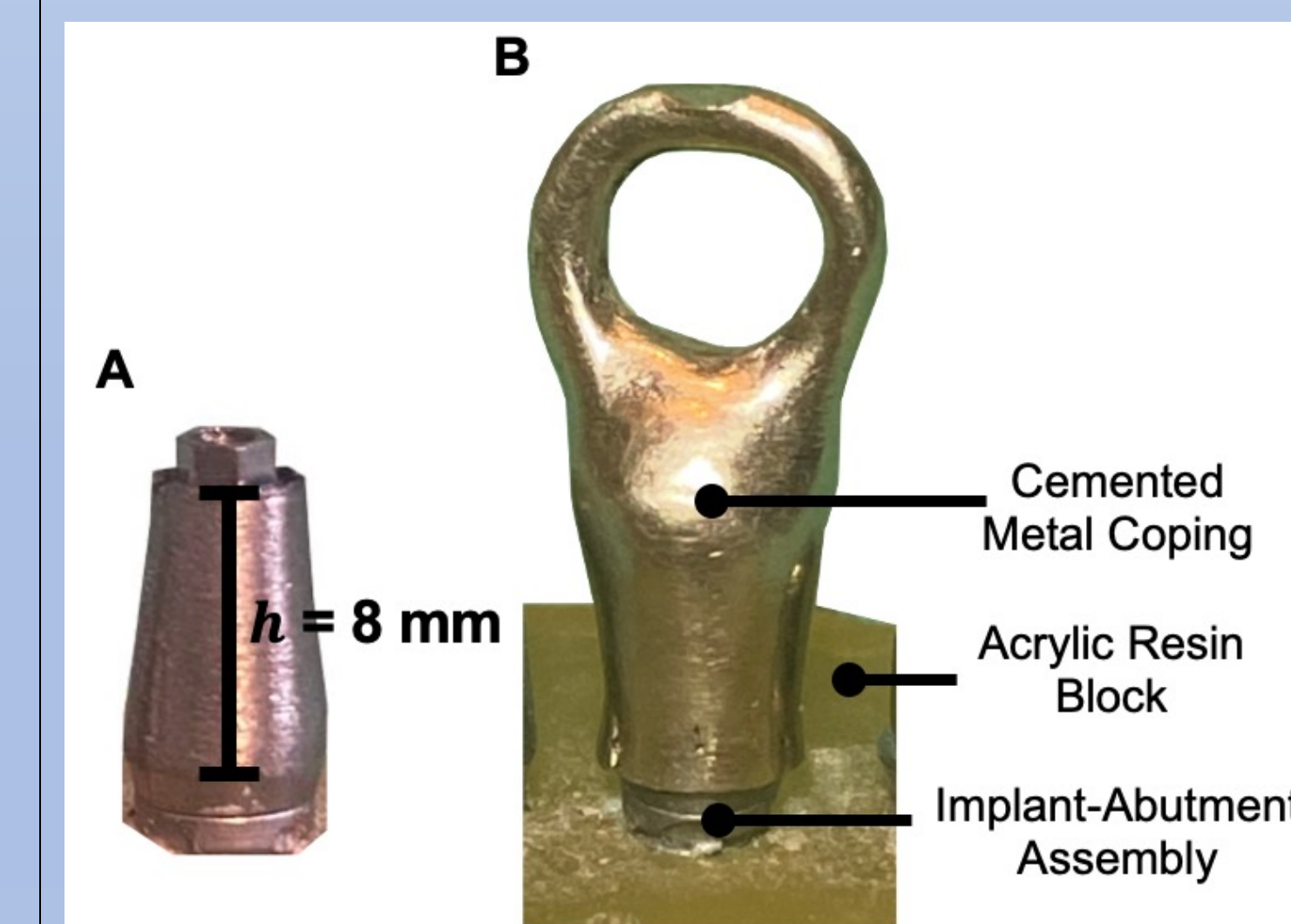


Fig 1. A: An 8° tapered abutment 8 mm in height (h) connected to an implant. **B:** Cemented metal coping on a tapered implant-abutment assembly embedded vertically in an acrylic resin block.

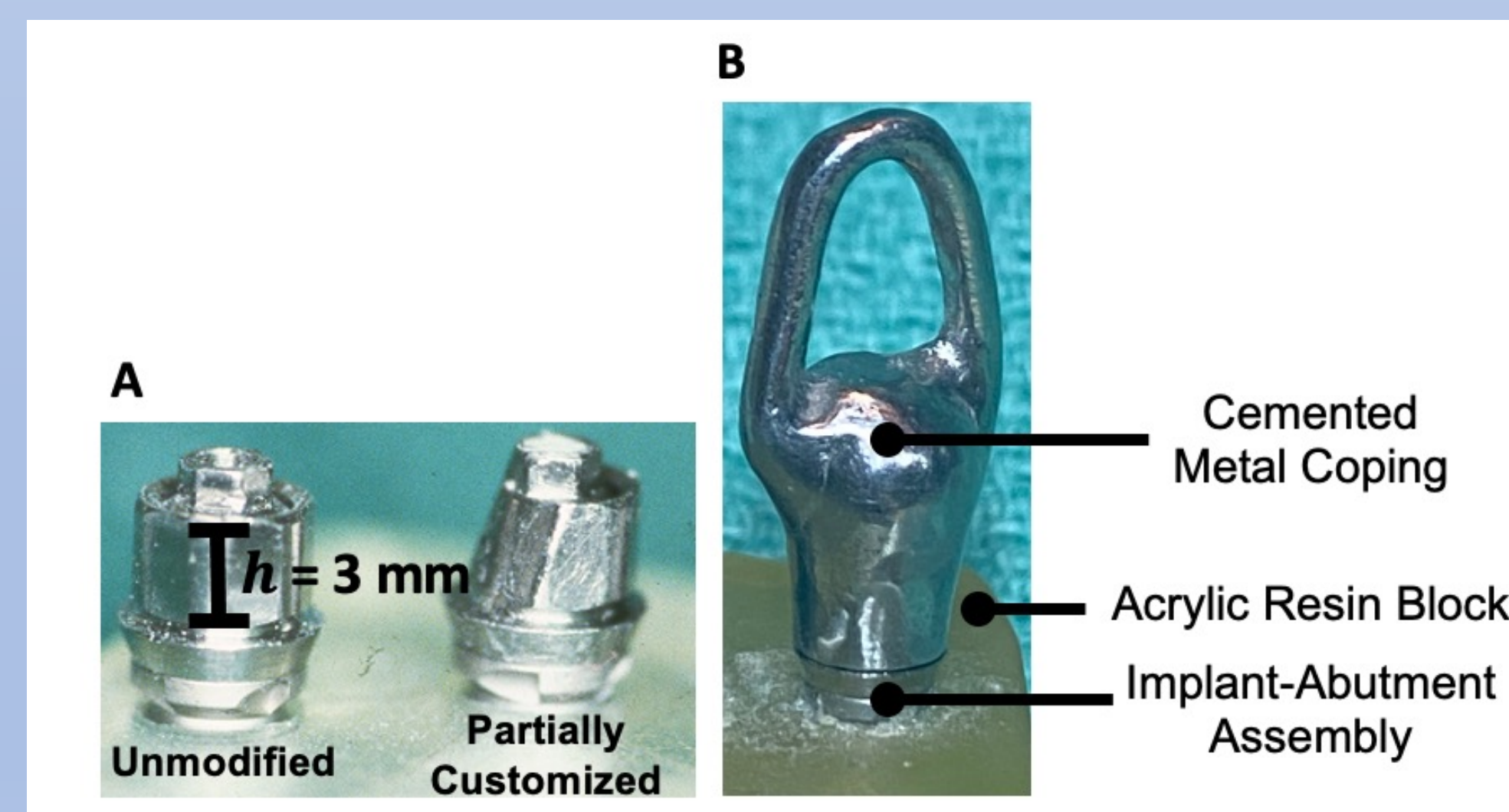


Fig 2. A: An unmodified machined hexagonal abutment 3 mm in height (h) and a partially customized hexagonal abutment with three contiguous vertical axial walls removed 3 mm in height (h). **B:** A cemented metal coping made from a prefabricated castable coping on a hexagonal implant-abutment assembly embedded vertically in an acrylic resin block.

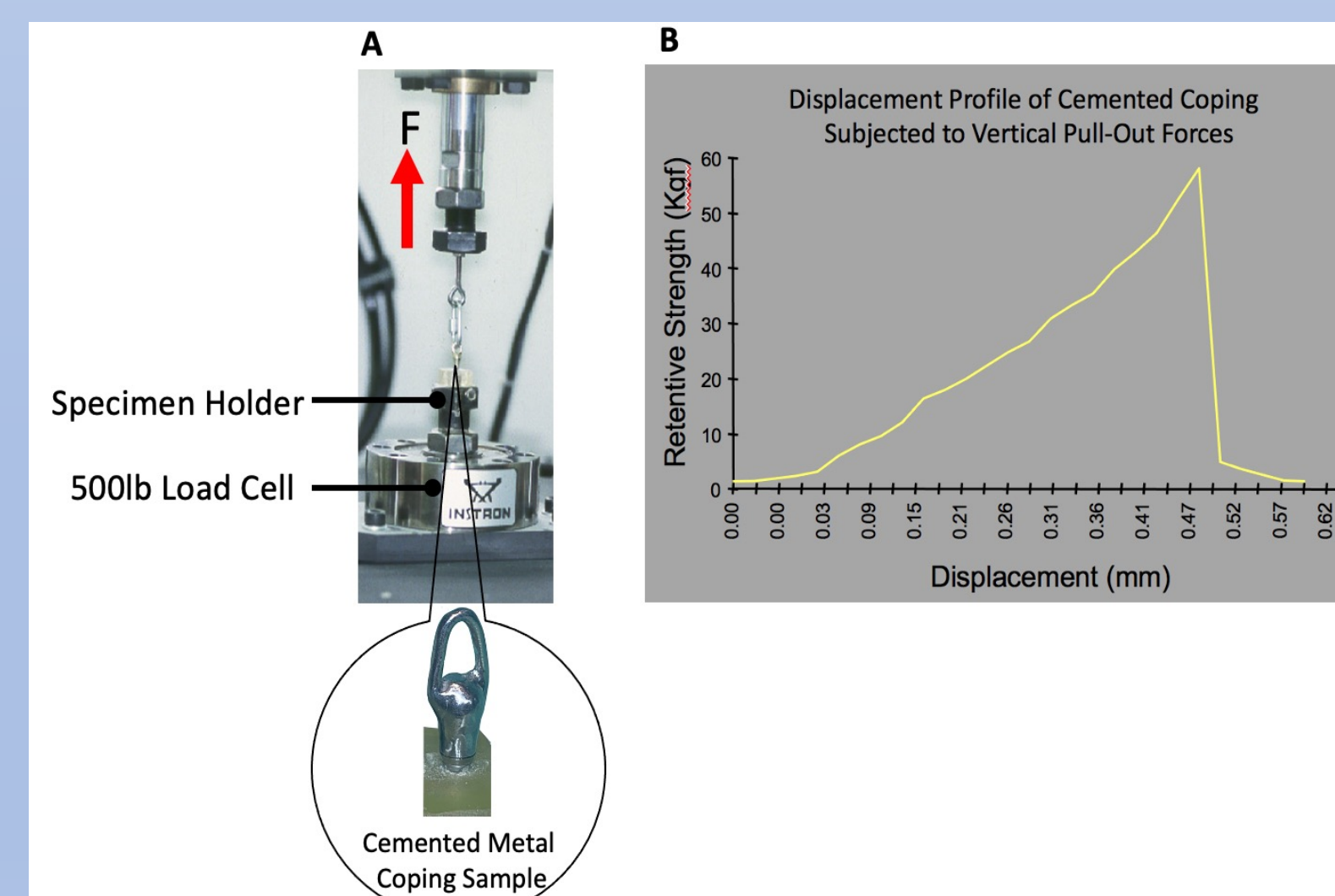


Fig 3. A: An exploded view of a cemented metal coping to an implant abutment assembly embedded in an acrylic block secured to a specimen holder connected to a 500 lbs load cell (F representing forces). **B:** The relationship between retentive strength (kgF) and position (mm) of a specimen subjected to vertical dislodgment forces.

Results

At each tapered abutment length, the retentive strength increased proportionally and was significantly different from $31.67 \pm \text{SD } 4.10 \text{ kgF}$ to $67.68 \pm \text{SD } 11.22 \text{ kgF}$, respectively [F (5,24) = 20.46, $p < 0.001$] (Fig 4). An unmodified hexagonal abutment demonstrated the highest retentive strength of $70.15 \pm \text{SD } 12.97 \text{ kgF}$ (Fig 5). Sequential removal of 1, 2, and 3 contiguous vertical axial walls of the hexagonal abutment was $59.89 \pm \text{SD } 10.06 \text{ kgF}$, $57.01 \pm \text{SD } 9.62 \text{ kgF}$, and $55.99 \pm \text{SD } 9.35 \text{ kgF}$, respectively with no significant difference ($p > 0.05$) in retentive strength (Fig 4).

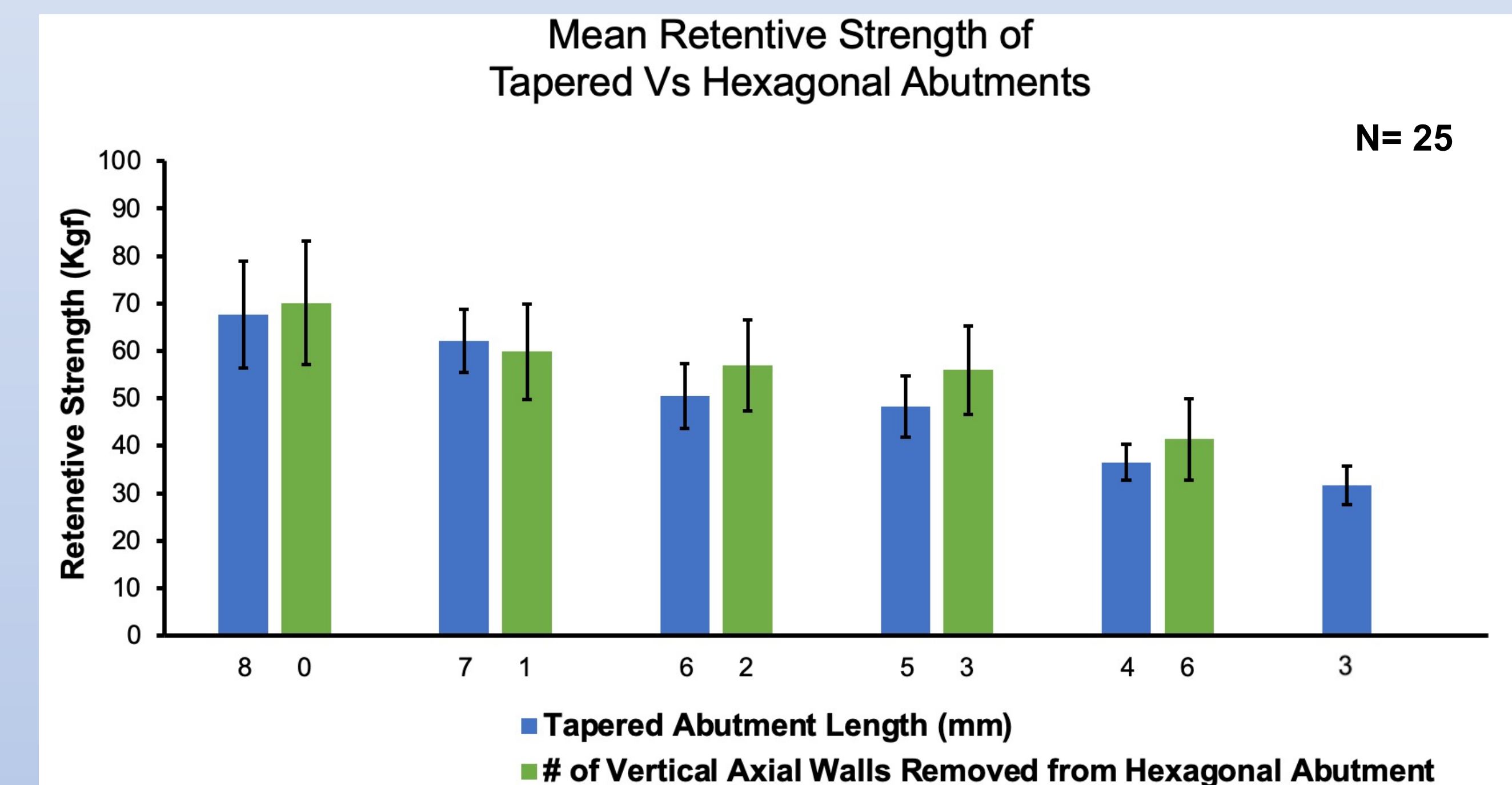


Fig 4. Average dislodgment force (kgF) of cemented metal copings on 8° tapered abutments of increasing abutment lengths from 3 to 8 mm and on an unmodified (0) hexagonal abutment and modified hexagonal abutments with 1, 2, and 3 vertical axial walls removed.

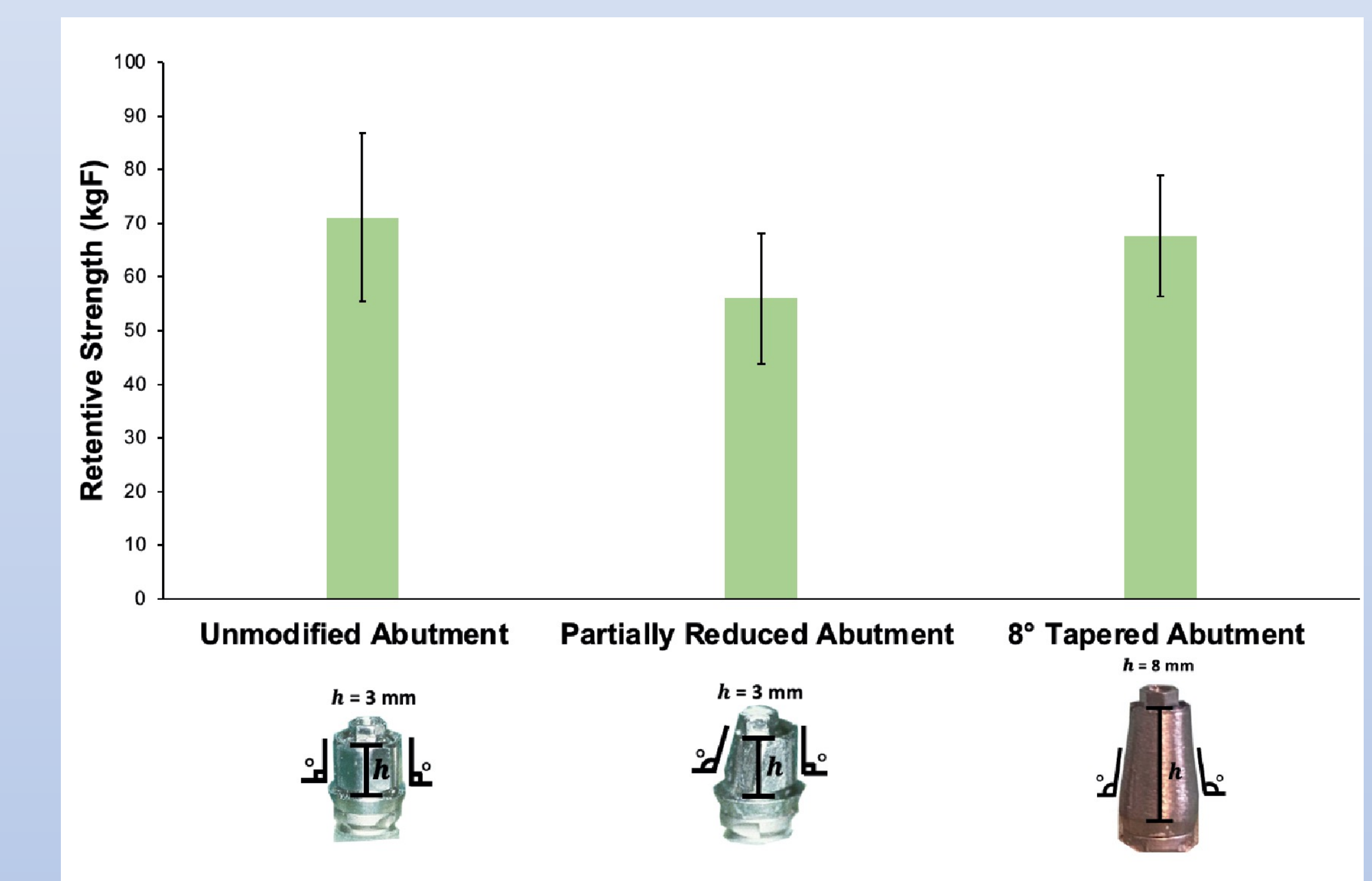


Fig 5. Average dislodgment force (kgF) of a 3 mm high unmodified hexagonal abutment, a 3 mm high partially customized hexagonal abutment (3 contiguous vertical axial walls removed), and an 8 mm high and 8° tapered abutment.

Conclusion & Clinical Implication

A partially customized abutment with vertical axial walls on one side and a profile reduction on the opposite side can provide comparable retention of cemented copings at 1/3 the length and 1/6 the surface area of an 8 mm high abutment with 8° taper. Additionally, a short partially reduced pre-formed hexagonal abutment to support a single implant crown in the esthetic zone would allow for more freedom in the placement of implants and a predictable esthetic restoration with a substantial reduction in cost and complications.

