



Effect of Margin Depth, Installation Pressure and Abutment-Prosthesis Design on Submarginal Cement and Open Margins: an in vitro study

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Abstract: The troubling prevalence of implant treatment complications related to both the screw-in and cement-in installation systems appear to be similar and treatment for peri-implant diseases can be uncomfortable and unpredictable.^{1,2} While intra-oral cementation system can optimize the fit of implant parts and improve access to care, it has also been plagued by complications related to residual subgingival cement and open margins.³⁻⁵ An intra-oral cementation system that could mitigate these risk factors for disease could be key to reducing treatment complications.⁶ **This study compares** the installation of single crowns of the common **Chamfer Margin System (CMS)** to a more recent **Reverse Margin System (RMS)**. The RMS was designed to mitigate the root causes of mechanical and related biological complications as described by Dr. Svoboda in previous publications.⁷ Both systems were tested with their abutment margins positioned at ½ to 1 mm subgingival, while their complementary crowns were cemented into place under varying pressure conditions. **Unlike the CMS, the RMS eliminated submarginal cement under low pressure conditions and open margins under all conditions.** The clinical implications of these results could serve as a foundation for improved treatment results. Further clinical trials are necessary to verify the efficacy of the RMS in vivo.

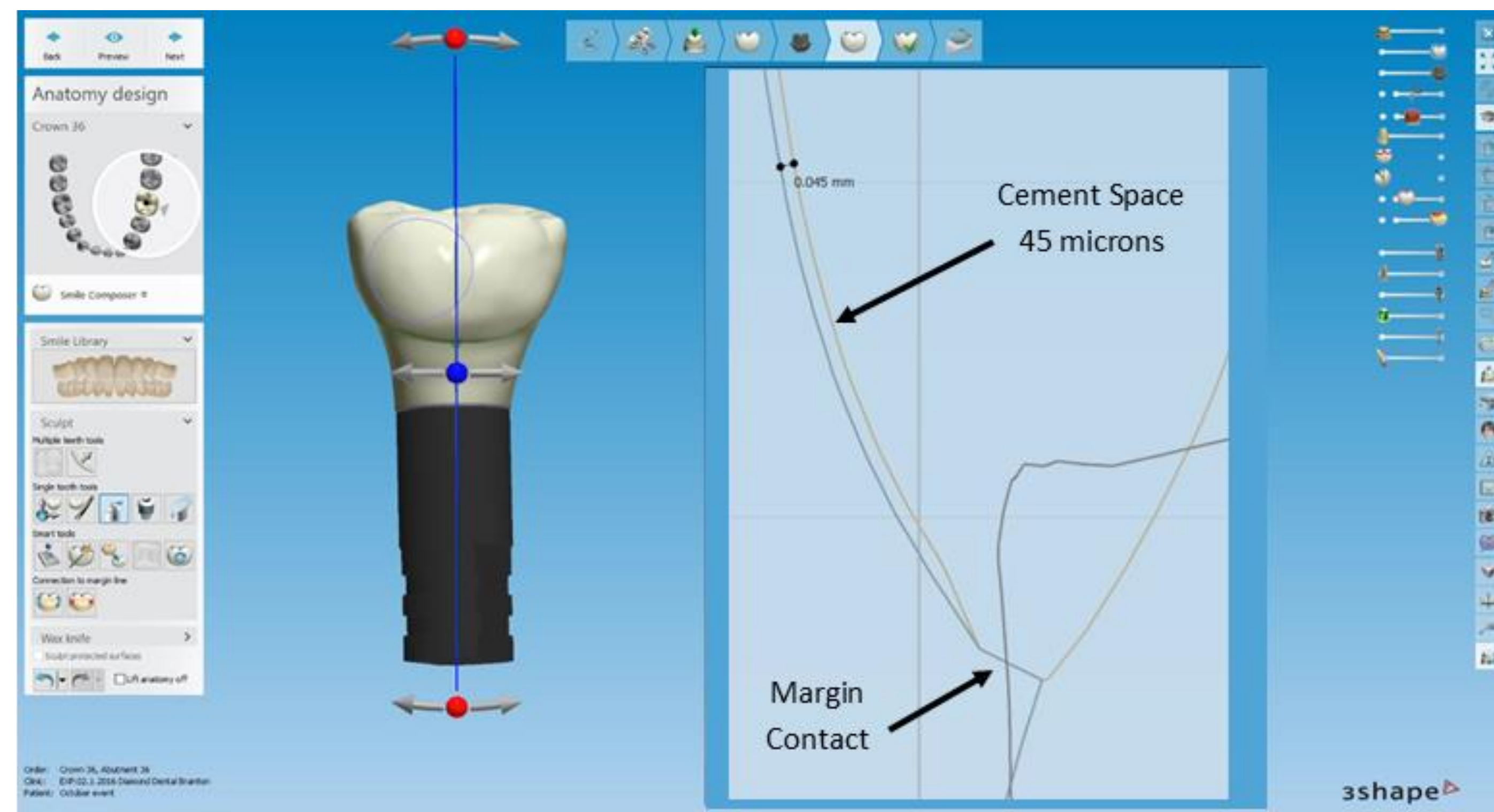


Fig 1: CMS Design: Crown profile emerging from smaller diameter abutment profile.

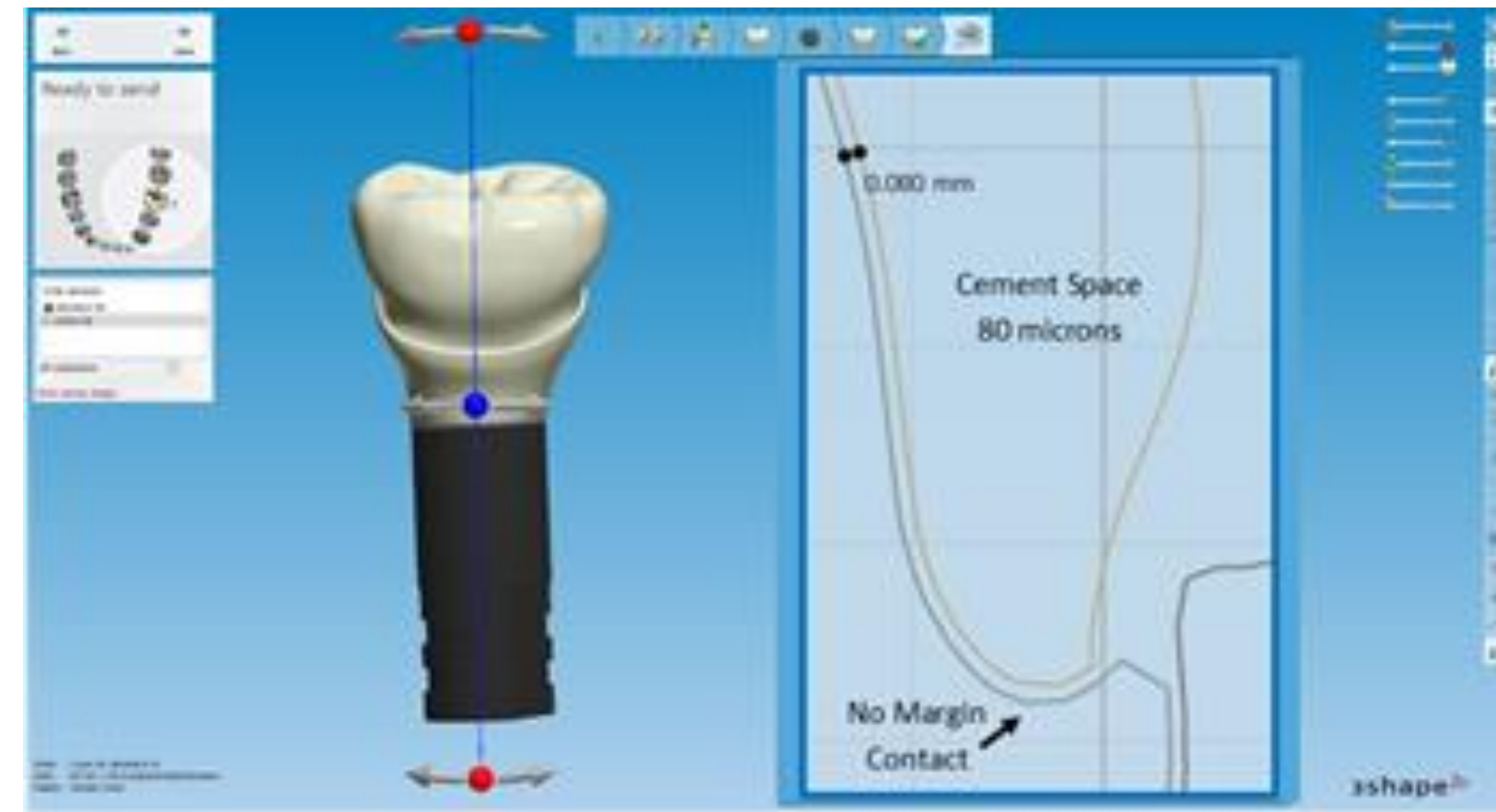


Fig 2: RMS Design: Crown profile emerging from larger diameter abutment profile.



Fig 3: Identical printed models with mastered gingiva, specific to abutment-crown system.

1) Effects of System Design and Installation Pressure on Submarginal Cement: Crown installation systems were alternated. (Figs -5) They were ½ filled with Rely X Unicem cement from mixing tube (3M), pressed into place over 5 seconds to reach the desired pressure and held for 5 more seconds before the cement was polymerized with an Elipar Deepcure S light (3M Espe). (Fig 6) Photographs were taken of the B, M, L and D aspects of each abutment-crown surface while placed beside a mm grid (Fig 7). The images were copied into a Windows Publisher program (www.Windows.com) and enlarged to facilitate the measurement process. (Fig 8) Table 1 shows the results of the sum of cement travel past B,M,L & D abutment margins. 10 Trials were completed for each installation system and pressure. Differences between groups were tested ($p \leq 0.05$) using the Mann-Whitney U test.

The RMS prevented cement from breaching the abutment margin better than the CMS at every pressure tested.
Unlike the CMS, the RMS eliminated submarginal cement at 2Kg or less cementation pressure. (Table 1)



Fig 4: Model with silicone gingiva and RMS abutment. The screw access hole is filled with pink Teflon tape.



Fig 5: RMS crown sits passively. Screw access hole filled with clear acrylic.



Fig 6: Crown is pressed into place while sitting on a weigh scale. Excess cement is expressed from its margins.



Fig 7: CMS with black dots showing cement travel beyond Buccal (B), Mesial (M), Lingual (L) and Distal (D) margins. Images placed beside mm ruler to measure cement travel distance.



Fig 8: RMS with no submarginal cement travel. B & L, margins were 1.0 & 0.5 mm subgingival. M & D were transitional in depth.

	Total	mm	
Pressure	System	Average	Range
5 Kg	CM	4.1	0-10.8
	RM	0.4	0-11.6
4 Kg	CM	4.0	0-11.5
	RM	0.1	0-1.0
2 Kg	CM	2.1	0.1-4.2
	RM	0	0
1 Kg	CM	0.7	0-3.3
	RM	0	0
0.5 Kg	CM	0.7	0-3.8
	RM	0	0

Table 1: RMS had no submarginal cement travel past any of its margins when crowns were installed at 2 Kg or less.

2) Effects of System Design and Installation Pressure on Open Margins

Polymerized excess cement was removed to reveal the margin interfaces and images were made of the B, M, L and D aspects of each surface while placed beside a mm grid (Fig 9). Control: There were no open margins when abutments were combined with crowns without gingiva, with or without cement. (Fig 10)

None of the RMS trials had any vertical openings between margins.

All the CMS trials had open margins at all installation pressures, and the space between margins increased with decreased installation pressure. (Table 2, Fig 11)

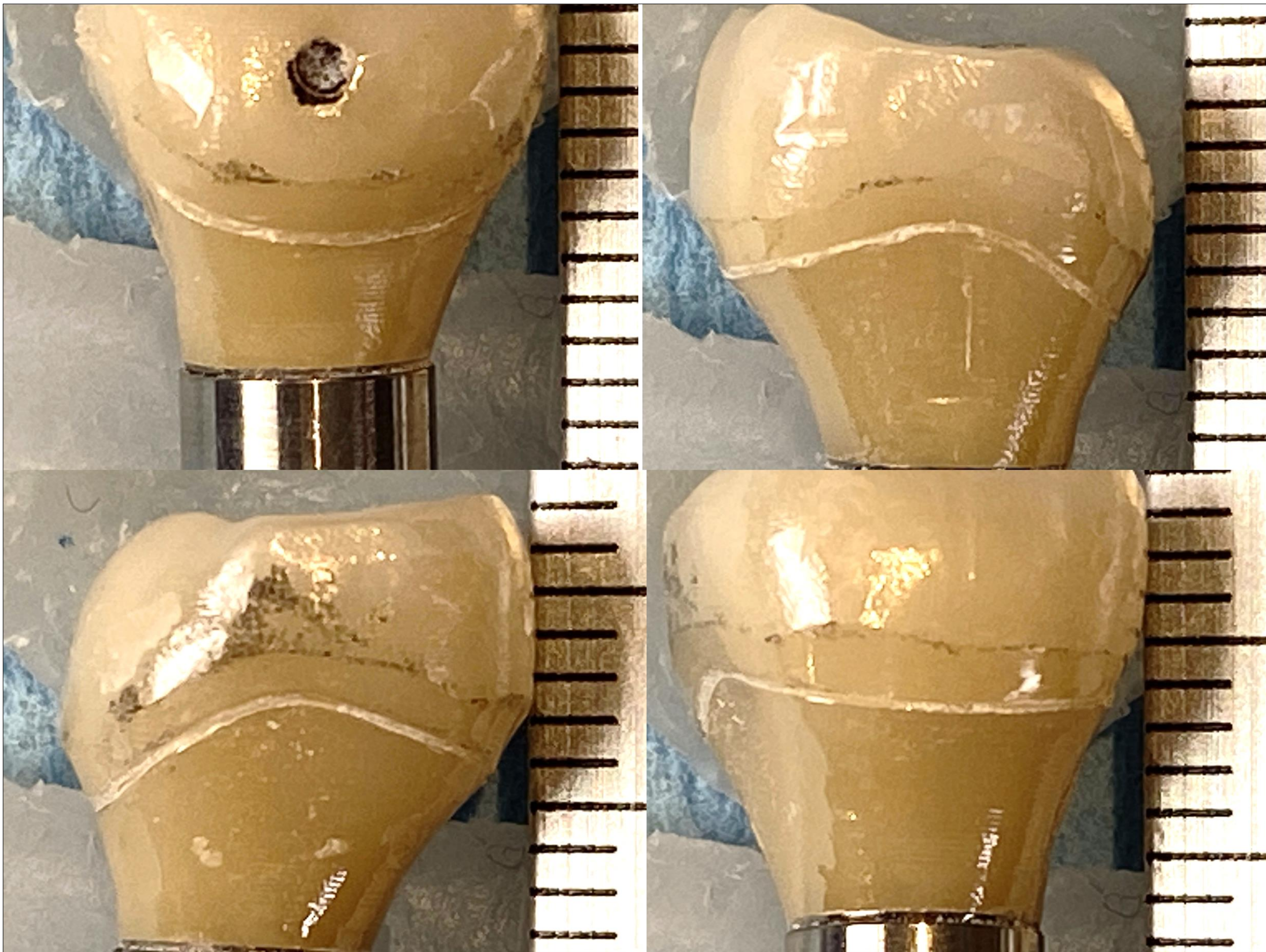


Fig 9: All 50 CMS trials had open margins.

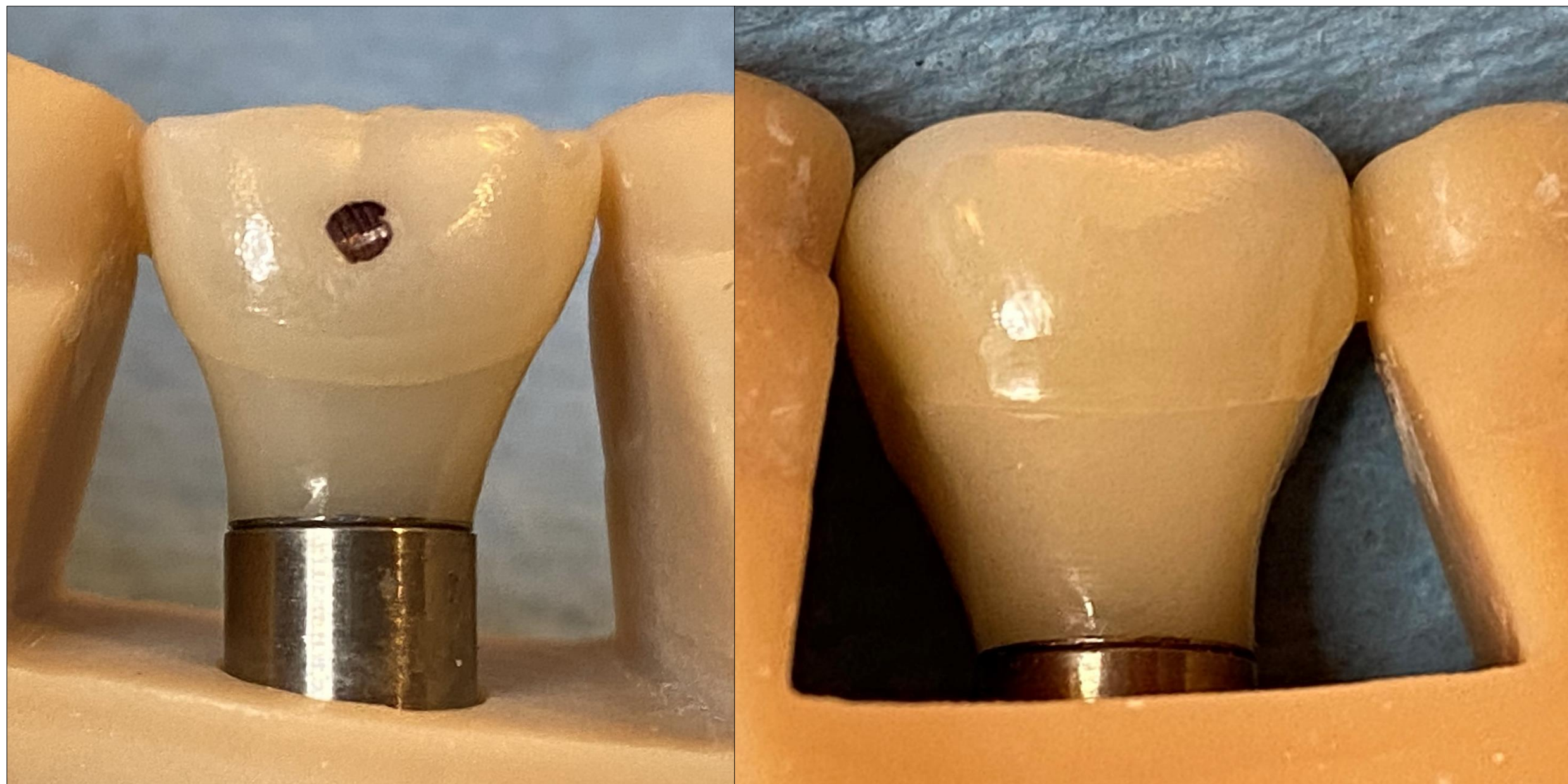


Fig 10: No CMS trials had open margins when cement and gingiva were eliminated.

Pressure	Total	mm	Range
	System	Average	
5 Kg	CM	0.1	0-0.3
4 Kg	CM	2.0	0-0.6
2 Kg	CM	0.1	0.1-0.3
1 Kg	CM	0.3	0-1.0
0.5 Kg	CM	0.3	0-0.7

Table 2: CMS trials tended to have wider open margins with decreasing cementation pressure.

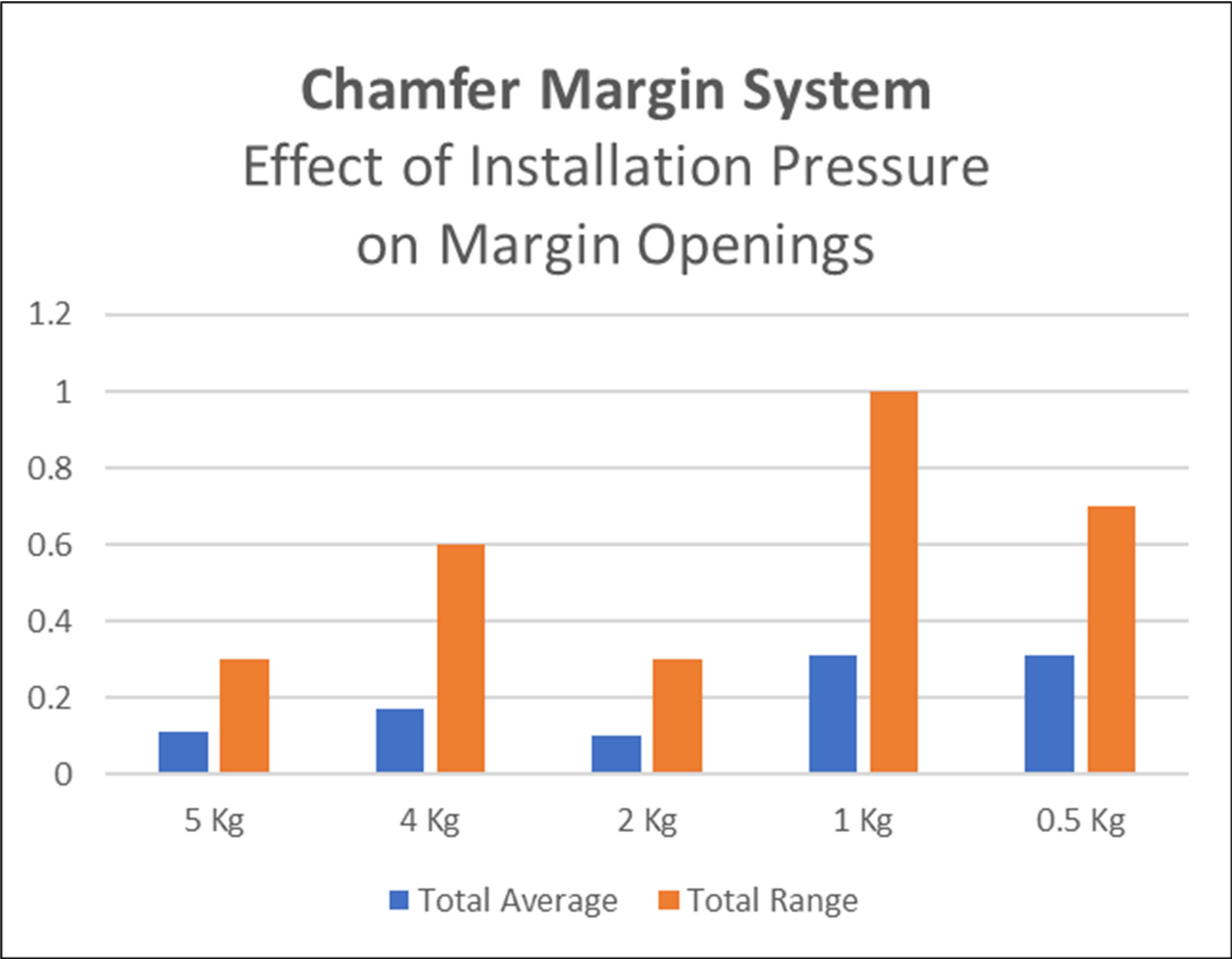
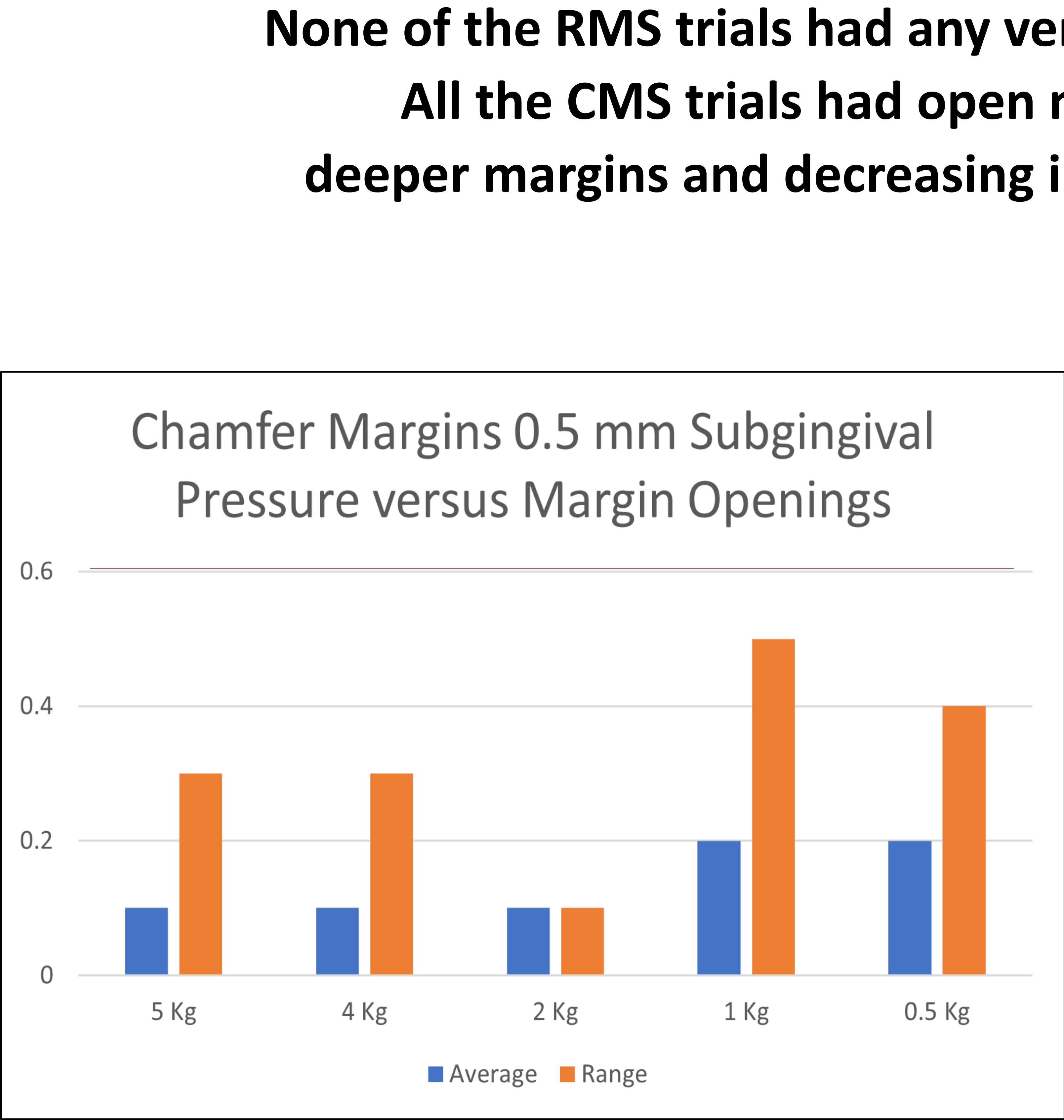
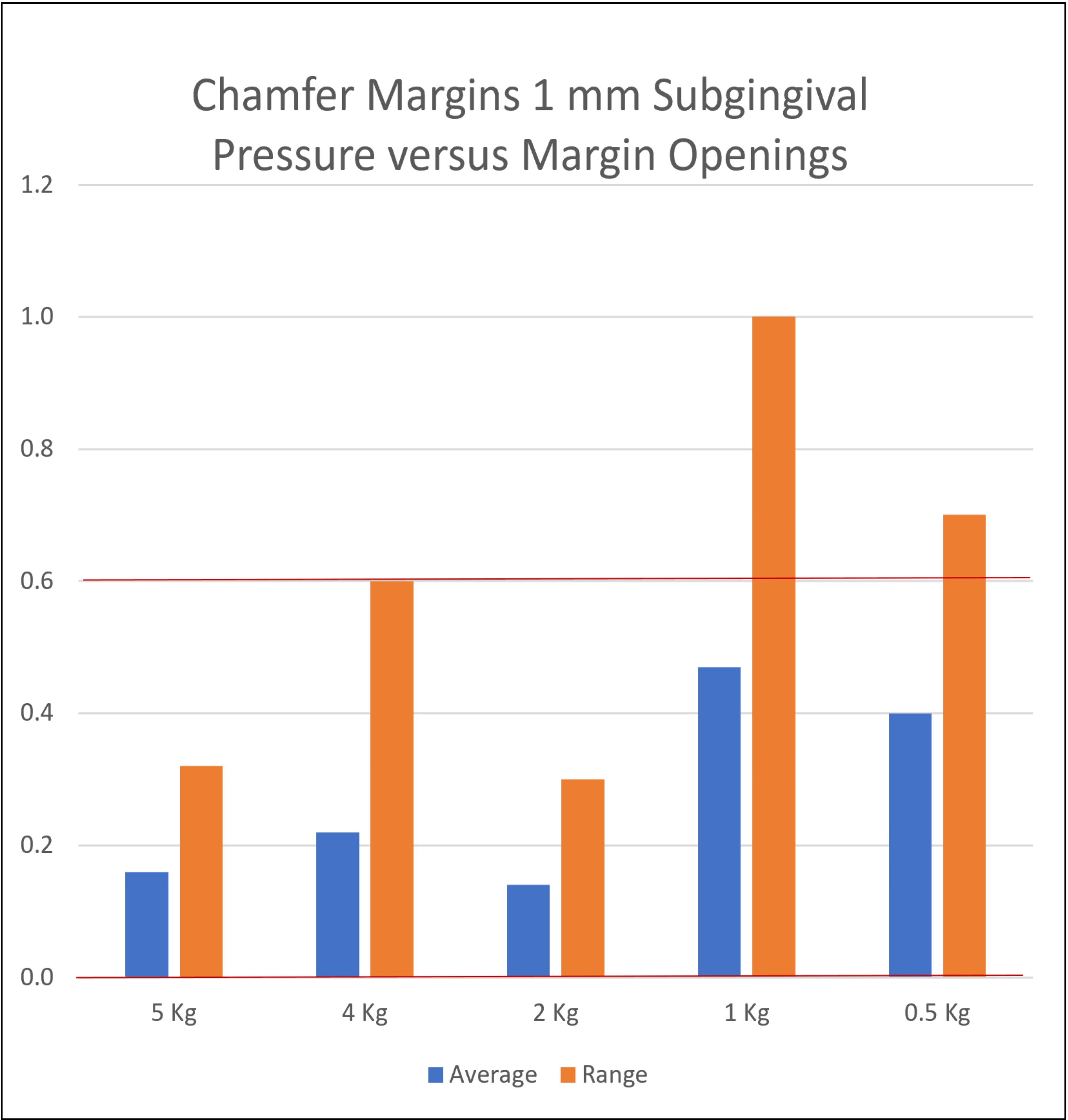


Fig 11: All CMS trials had open margins that increased vertical separation with decreasing cementation pressure.

3) Effects of System Design, Installation Pressure and Margin Depth on Open Margins:

Excess cement was removed to reveal margins and an iPhone 11 pro was used to make images of the B, M, L and D aspects of each surface while placed beside a mm grid, as described previously in 2).



None of the RMS trials had any vertical openings between their margins.
All the CMS trials had open margins that increased with both deeper margins and decreasing installation pressure. (Figs 12,13 Table 3)

	-1 mm		-0.5 mm	
Pressure	Average	Range	Average	Range
5 Kg	0.2	0.1-0.3	0.1	0-0.3
4 Kg	0.2	0-0.6	0.1	0-0.3
2 Kg	0.1	0-0.3	0.1	0-0.1
1 Kg	0.5	0-1.0	0.2	0-0.5
0.5 Kg	0.4	0.1-0.7	0.2	0-0.4

Table 3: Shows the average and range of vertical separation between abutment and crown margins when measured at the center of the B and L margins. The abutment margins were positioned 1.0 and 0.5 mm below the gingiva.

Fig 12 and Fig 13 above show the vertical separation of open margins when abutment margins were placed 1.0 and 0.5 mm subgingival, respectively. The red horizontal line indicates a common scale for comparison.

Discussion: Unlike the CMS, the RMS was designed to be sensitive to and mitigate the root causes of complications as described by Dr. Svoboda. The RMS provides dentists with a means of safely using a low-pressure cementation system to protect patients from misfit implant parts, subgingival cement and open margins. All these are recognized risk factors for complications, including the prevalent and dreaded peri-implant disease. 5

Previous publications introduce new terminology to facilitate discussion about the root causes of complications, 7 how the RMS works, and how it can be integrated into more complex prostheses installation systems based on the common screw-in installation systems: to consistently optimize the fit of implant parts, reduce the width of prostheses profiles to provide better access to care, and segment the final prosthesis to reduce the negative repercussions of a failing or failed implant. 8,9

Once researchers can predictably reduce the impact of the above risk factors on complications, it may become possible to assess the impact of more subtle variations of treatment on the prevalence of complications. This could help foster the development of a new standard of care that is able to evolve more rapidly over time.

Conclusions:

- 1) The RMS consistently outperformed the CMS in preventing subgingival cement under all conditions.
- 2) Unlike the CMS, the RMS eliminated both submarginal cement and open margins under low pressure crown installation conditions.
- 3) The results of this study further support the concepts about the root causes of complications, as described in Dr. Svoboda’s “Terminology article”. 7
- 4) More clinical studies are warranted to further demonstrate the efficacy of the RMS at making dental treatment better for patients.

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Authors: Dr. Svoboda is the inventor of the RMS and holds patents on its design. Drs. Cheema and Sharma have no financial interest in this system.