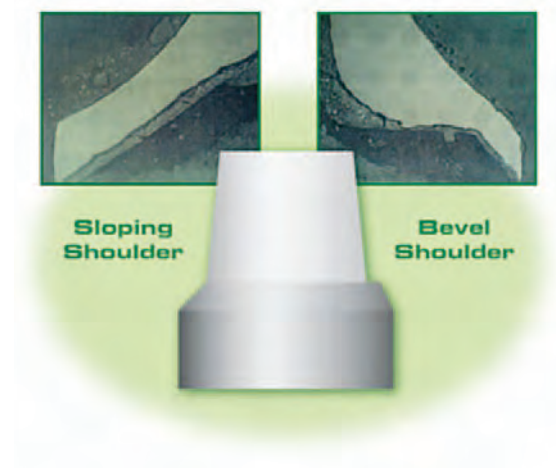


## Evaluating the Effect of a Sloping Shoulder and a Shoulder Bevel on the Marginal Integrity of Porcelain-Fused-to-Metal (PFM) Veneer Crowns

Ezzatollah Jalalian, DDS, MSD; Hamed Jannati, DDS; Maryam Mirzaei



### Abstract

**Aim:** A porcelain-fused-to-metal (PFM) veneer crown restoration is considered successful when biological, mechanical, and esthetical concerns are satisfied. Restorations with poor marginal integrity may contribute to the cause of severe caries and periodontal defects. The most important factor in achieving successful marginal integrity is preparation design. Although a sloping shoulder preparation offers biologic and esthetic advantages over a shoulder bevel, a comparison of the marginal integrity of these two designs is less clear and is the main focus of this study.

**Methods and Materials:** This study was based on the analysis of 40 PFM veneer specimens fabricated on 20 stone dies. Each die had a beveled shoulder on one side of the preparation and a sloping shoulder design on the other. All specimens were selected and managed in an identical manner throughout the entire experimental process. All specimens were fabricated on stone dies made from a standard stainless steel die with the two shoulder designs in the preparation. Marginal integrity of the PFM veneers was evaluated using a scanning electron microscope to measure the gap between the restoration and tooth margin. The data were analyzed using the Student t-test at a significance level of  $p > 0.05$ .

**Results:** An average amount of gap ( $\pm$  SD) for the test groups were as follows: shoulder bevel,  $40.78 \pm 18.4$  microns; sloping shoulder,  $52.8 \pm 27.4$  microns ( $p > 0.05$ ). All the data were within acceptable clinical range and no significant difference between two preparation designs were observed.

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**Conclusions:** Within the limitations of this study the marginal integrity of both preparation designs were found to be similar. Since the sloping shoulder design offers biological and esthetical advantages over the shoulder bevel, its use is indicated for anterior restorations.

**Keywords:** Esthetics, marginal integrity, shoulder preparation, marginal gap

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## Introduction

Marginal integrity is a critical factor in the success or failure of a cast porcelain-fused-to-metal (PFM) veneer crown restoration. If margins are not managed appropriately, they may contribute to the cause of many clinical problems. If the gap between the prepared tooth and the crown margins is more than the acceptable standard, the exposed soluble dental cement will dissolve rapidly.<sup>1</sup> Cariogenic microorganisms accumulate in the void and cause caries development under the crown.<sup>2,3</sup>

Food, debris, and by-products of microorganism activity in carious regions have the ability to provoke the vital pulp.<sup>4</sup> Poor marginal integrity can cause an increase in microbial plaque,<sup>5</sup> changes in the subgingival flora,<sup>6</sup> gingival inflammation,<sup>7,8</sup> and color changes in the marginal gingiva.<sup>9,13</sup> In severe cases an increase in pocket depth and loss of attached gingiva may occur.<sup>1-4</sup> Several clinical reports support this theory.<sup>5</sup> Goto<sup>5</sup> confirms the relation between inappropriate marginal integrity and gingival inflammation and reports the most important factor in periodontal disease prevalence is an unsuitable marginal fit. Henderson and Myers<sup>6,7</sup> have also claimed an increase in caries and periodontal disease leads to crown failure, or even to loss of the tooth itself. In light of these issues a PFM veneer crown preparation design that satisfies marginal integrity requirements along with the other specifications required for a desirable veneer, such as esthetics and the preservation of biological needs, represents a challenge.

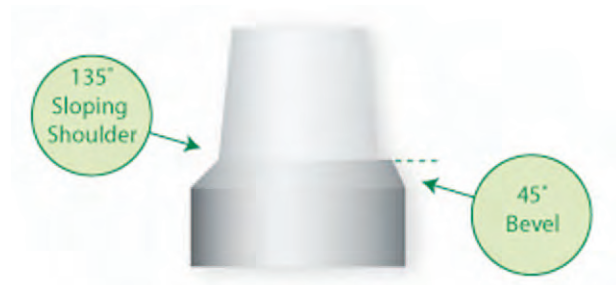
Reducing and even eliminating the metal collar on the labial surface of a PFM veneer crown is an attempt to address the increasing demand for esthetics. However, marginal integrity has become an issue in many cases. Therefore,

comparing the marginal integrity between a shoulder bevel which provides a desirable seal<sup>14</sup> and a sloping shoulder which offers a minimal collar, esthetics, and periodontal preservation<sup>15</sup> is of considerable importance. If such a comparison of marginal integrity reveals no significant difference between these preparation designs, then it could be concluded the sloping shoulder has a greater indication for restoring anterior teeth due to its other clinical advantages. Therefore, the aim of this study is to compare the marginal integrity of shoulder bevel and sloping shoulder preparation in cast PFM veneer crown restorations.

## Materials and Methods

This *in vitro*, double-blind study employed the use of standard stainless steel dies. Half of the marginal area of the dies was prepared with a 45° shoulder bevel preparation and the other half was prepared with a 135° sloping shoulder. The axial walls were prepared with a 10° convergence toward the occlusal surface (Figures 1 to 3).

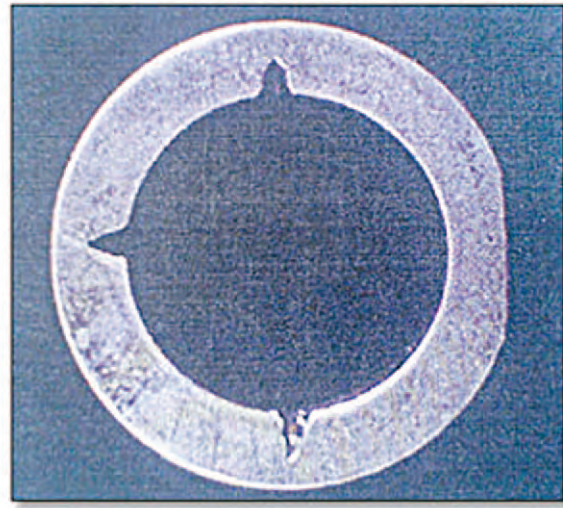
Twenty identical standard molds of the stainless steel dies using additional silicon were prepared; then twenty stone dies (Type IV dental stone) were prepared using the molds. All of the



**Figure 1.** Preparation designs.



**Figure 2.** Standard dye (lateral view).



**Figure 3.** Standard dye (top view).

specimens were prepared on stone dies made from the standard stainless steel die that had one side prepared with a shoulder bevel design and the other side with a sloping shoulder design. PFM veneer crowns were then made for all twenty dies using an identical fabrication technique. All dies were treated equally throughout the entire experiment. The PFM veneer crowns were cemented on the dies using zinc phosphate cement under equal pressure and temperature.

The samples were then totally immersed in transparent acrylic for better handling and allowed to set. Abrasion techniques were used to cut through the long axis and to polish the samples in preparation for evaluation using a scanning electron microscope (SEM). All the samples were covered by a thin layer of gold as a conductor material in order to achieve object detection under the SEM. The gap between the metal frame of the PFM veneer crown and the stone die was measured in microns at the cervical margin area of the restorations (Figures 4 and 5).

The data was processed using SPSS software (SPSS, Inc., Chicago, IL, USA), and the difference between the two preparation designs was analyzed using the Student t-Test.

### Results

This experimental study was conducted on forty samples, twenty in the beveled shoulder group and twenty in the sloping shoulder group that were made on twenty stone dies. The measured gap in Group A (shoulder bevel) was  $40.78 \pm 18.4$  microns

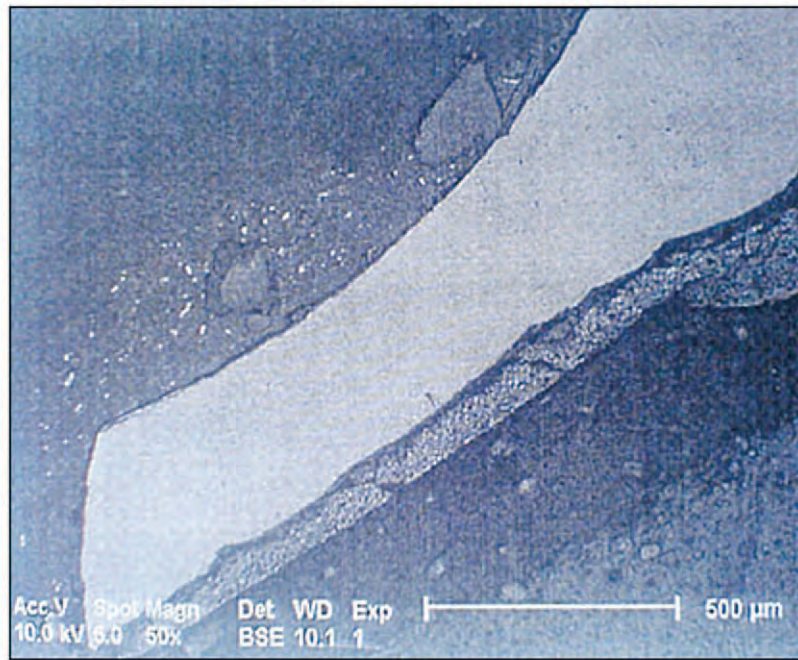
and  $52.8 \pm 27.4$  microns in Group B (sloping shoulder). This is a 12.02 micron or 29.6% smaller gap in the shoulder bevel compared to the sloping shoulder. The Student t-test showed this difference to be statistically insignificant ( $p > 0.05$ ) (Table 1). Both preparation designs are within an acceptable range and no clinical difference could be observed.

### Discussion

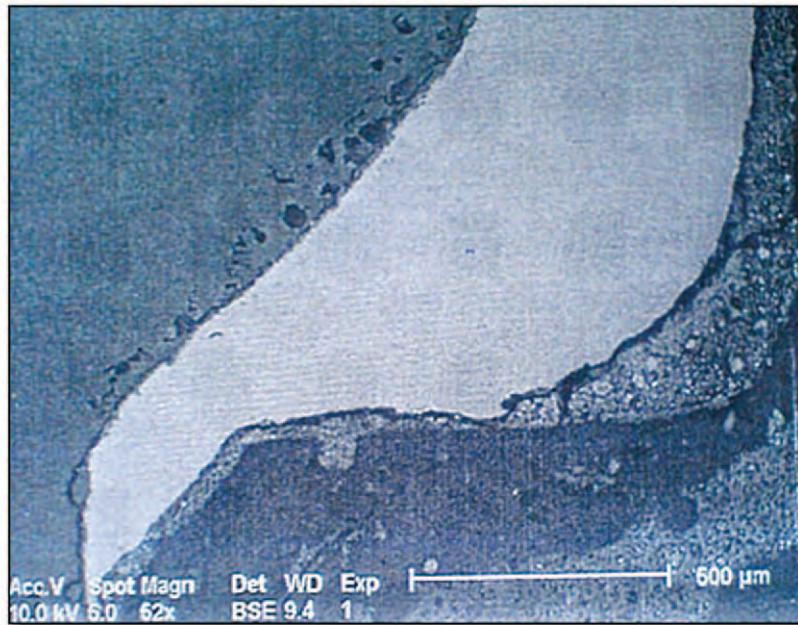
This study indicates both preparation designs have an acceptable marginal integrity, but the shoulder bevel shows a better and more convenient marginal integrity. Panno<sup>16</sup> reported an average gap of 45 microns for a shoulder bevel in his study, whereas Gavelis<sup>17</sup> reported a 44 micron average and Faucher<sup>18</sup> reported an average gap of 62 microns.

Marginal integrity is an important factor in the success of a casting restoration such as a PFM veneer crown. The shoulder bevel design has shown it satisfies the need for a suitable marginal integrity. However, a restoration has to satisfy other needs such as esthetics and the biological health of gingiva by providing for more space on the metallic frame for the porcelain layer. The sloping shoulder design is a better choice for the achievement of better color and contours in the final restoration because more space is available for porcelain on the metal frame.

The results of this study suggest the use of a sloping shoulder in a PFM veneer restoration is preferable in the anterior segment due to the



**Figure 4.** Amount of gap in sloping shoulder preparation design under an electron microscope.



**Figure 5.** Amount of gap in shoulder bevel preparation design under an electron microscope.

**Table 1.** Gap measured in two preparation designs.

Result	P-value	Average ± SD	Index/Group
The difference is not statistically significant.	p>0.05	40/78±18.41	A
		52/8±27.4	B

esthetic advantage it provides. The shoulder bevel is indicated in the posterior segment because esthetics is less important and the range of the gap is smaller.

### Conclusion

The results indicate the shoulder bevel has no advantage over the sloping shoulder in terms of

marginal integrity. Therefore, within the limits of this study it can be concluded the sloping shoulder is a more favorable design for PFM restorations in the anterior segment of the mouth because it offers a more conveniently achievable esthetic result and a favorable biological advantage than the shoulder bevel.

### References

1. Jacobs MS, Windeler AS. An investigation of dental luting cement solubility as a function of the marginal gap. *J Prosthet Dent.* 1991 Mar;65(3):436-42.
2. Phillips RW, Swartz ML, Lund MS, Moore BK, Vickery J. *In vivo* disintegration of luting cements. *J Am Dent Assoc.* 1987 Apr;114(4):489-92.
3. Preston JD. Rational approach to tooth preparation for ceramo-metal restorations. *Dent Clin North Am.* 1977 Oct;21(4):683-98.
4. Goldman M, Laosonthorn P, White RR. Microleakage—full crowns and the dental pulp. *J Endod.* 1992 Oct;18(10):473-5.
5. Khu CH, King NM, Lee AM, Yiu CK, Wei SH. A pilot study of the marginal adaptation and surface morphology of glass-cermet cements. *Quintessence Int.* 1996 Jul;27(7):493-501.
6. Lang NP, Kiel RA, Anderhalden K. Clinical and microbiological effects of subgingival restorations with overhanging or clinically perfect margins. *J Clin Periodontol.* 1983 Nov;10(6):563-78.
7. Schwartz NL, Whitsett LD, Berry TG, Stewart JL. Unserviceable crowns and fixed partial dentures: life-span and causes for loss of serviceability. *J Am Dent Assoc.* 1970 Dec;81(6):1395-401.
8. Walton JN, Gardner FM, Agar JR. A survey of crown and fixed partial denture failures: length of service and reasons for replacement. *J Prosthet Dent.* 1986 Oct;56(4):416-21.
9. Waerhaug J. Histologic considerations which concern where the margins of restoration should be located in relation to gingival. *Dent Clin North Am* 1960; 4:161-176.
10. Løe H. Reactions to marginal periodontal tissues to restorative procedures. *Int Dent J.* 1968 Dec;18(4):759-78.
11. Orstavik D, Orstavik J. *In vitro* attachment of *Streptococcus sanguis* to dental crown and bridge cements. *J Oral Rehabil.* 1976 Apr;3(2):139-44.
12. Brännström M. Communication between the oral cavity and the dental pulp associated with restorative treatment. *Oper Dent.* 1984 Spring;9(2):57-68.
13. Tjan AH, Li T, Logan GI, Baum L. Marginal accuracy of complete crowns made from alternative casting alloys. *J Prosthet Dent.* 1991 Aug;66(2):157-64.
14. Syu JZ, Byrne G, Laub LW, Land MF. Influence of finish-line geometry on the fit of crowns. *Int J Prosthodont.* 1993 Jan-Feb;6(1):25-30.
15. Rosenstiel SF, Land MF, Fujimoto J. *Contemporary Fixed Prosthodontics*, 4th Edition. Mosby/Elsevier, St. Louis, Mo. 2006; 219-23.
16. Panno FV, Vahidi F, Gulker I, Ghalili KM. Evaluation of the 45-degree labial bevel with a shoulder preparation. *J Prosthet Dent.* 1986 Dec;56(6):655-61.
17. Gavelis JR, Morency JD, Riley ED, Sozio RB. The effect of various finish line preparations on the marginal seal and occlusal seat of full crown preparations. *J Prosthet Dent.* 1981 Feb;45(2):138-45.
18. Faucher RR, Nicholls JI. Distortion related to margin design in porcelain-fused-to-metal restorations. *J Prosthet Dent.* 1980 Feb;43(2):149-55.

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