# The Evaluation of Marginal Gap With and Without Optical Aids: Clinicians Versus Technicians

Gaetano Calesini, MD, DDS, CDT[a]/Costanza Micarelli, DDS[a]/Andrea Fabianelli, DDS, MSc, PhD[b]/
Federica Papacchini, DDS, MSc, PhD[c]

***Purpose:*** This study investigated the reliability of visual assessment of marginal gaps in relation to the use of magnification and the operator's profession. ***Materials and Methods:*** A titanium bar was notched, simulating 40 marginal gaps, and 35 operators performed a quantitative evaluation of the incisions. ***Results:*** Visual examination was neither sensitive nor specific, as an extreme variability of data was recorded. The precision of readers improved with magnification aids only for clinicians; technicians were significantly more accurate in evaluating the incision's width. ***Conclusion:*** The visual examinations were inadequate to decide the clinical acceptability of a restoration with regard to its marginal fit. *Int J Prosthodont 2014;27:161–164. doi: 10.11607/ijp.3649*

One of the main factors that characterizes the quality of a prosthetic restoration is the accuracy of the marginal seal. In fact, marginal defects were correlated with both secondary caries and periodontal complications.[1] Although the importance of the marginal fit of direct/indirect restorations is widely recognized, there is no agreement on marginal gap definition, with reported values ranging from 30 to 200 μm, nor on a common method of evaluation.[2] A valid technique to assess a gap smaller than 100 μm is missing.[3]

To appraise the accuracy of prosthetic fit, several methods have been suggested, to be performed alone or in combination. These include radiography, probing, use of an internal fit-checker, precision impression taking, and direct observation.[4] However, none showed results suitable for a quantitative and repeatable evaluation. The use of optical aids has been reported to improve gap evaluation for the operator.[5]

[a]*Private Practice, Rome, Italy.*
[b]*Visiting Lecturer, University of Sheffield, United Kingdom; Visiting Lecturer, University of Brescia, Italy; Private Practice, Cortona, Arezzo, Italy.*
[c]*Private Practice, Viterbo, Italy.*

**Correspondence to:** *Dr Gaetano Calesini, Via della Croce 77, Rome, 00187 Italy. Fax: 0039 06.6784921. Email: gaetano.calesini@studiocalesini.it*



The assessment of marginal fit is therefore qualitative and essentially based on a yes/no criterion: the choice is related to the acceptability or unacceptability of the gap perceived and estimated by the observer, both in the laboratory and in the clinic.

This in vitro study aimed to determine the discriminatory ability of different operators in assessing marginal gap using direct vision with and without optical magnification.

The null hypotheses were that clinicians and technicians have the same ability to detect marginal discrepancies and that the use of magnification does not affect the evaluation.

## Materials and Methods

Forty grooves were notched at a distance of 1 cm in a randomized sequence onto a titanium bar to simulate marginal gaps ranging from 10 to 200 μm in width. To visually evaluate and quantify the incisions, 18 clinicians skilled in prosthodontics and 17 technicians were enrolled, each of them twice, on different days. The operators had different years of experience in the dental field, varying from 15 to 55. They were requested to quantitatively estimate the gaps, without any indication about the incision's width. Readings were carried out consecutively from the 1st to the 40th incision, five times with the naked eye and five times with magnifications aids: clinicians used prismatic dental loupes at ×4 magnification and at a focal distance of 30 cm (EyeMagProS, Carl Zeiss), while technicians performed the same readings using a Leica microscope at ×10 magnification (Leica).

**Table 1** Sample Size, Means, SDs, and Coefficients of Variation of the Readings Registered by the Operators for Each Group of Incisions With and Without Magnifications

| Real value (μm) | Clinicians (NoMAG) | | | | | Clinicians (MAG) | | | | | Technicians (NoMAG) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | Mean (μm) | SD (μm) | CV% | *P* | N | Mean | SD | CV% | *P* | N | Mean | SD | CV% | *P* |
| 10 | 269 | 69.4 | 124.0 | 178.7 | *** | 270 | 73.9 | 116.4 | 157.5 | *** | 255 | 62.3 | 60.1 | 96.4 | *** |
| 20 | 179 | 70.8 | 95.0 | 134.2 | *** | 180 | 73.4 | 74.1 | 101.0 | *** | 170 | 43.2 | 19.8 | 45.8 | *** |
| 30 | 177 | 35.7 | 57.9 | 162.3 | *** | 180 | 39.2 | 46.7 | 119.0 | *** | 170 | 12.0 | 6.9 | 57.3 | *** |
| 40 | 179 | 81.3 | 106.8 | 131.3 | *** | 180 | 83.9 | 100.0 | 119.1 | *** | 170 | 31.7 | 21.6 | 68.1 | *** |
| 50 | 179 | 91.4 | 126.3 | 138.1 | *** | 180 | 94.2 | 100.8 | 107.1 | *** | 170 | 53.5 | 50.1 | 93.6 | NS |
| 60 | 357 | 35.9 | 50.6 | 141.1 | *** | 360 | 40.7 | 44.6 | 109.6 | *** | 340 | 25.2 | 18.5 | 73.3 | *** |
| 70 | 179 | 83.7 | 111.2 | 133.0 | *** | 180 | 80.4 | 87.6 | 109.0 | *** | 170 | 50.6 | 23.5 | 46.5 | *** |
| 80 | 178 | 48.4 | 67.8 | 140.2 | *** | 180 | 51.4 | 54.2 | 105.6 | *** | 170 | 19.3 | 12.9 | 66.9 | *** |
| 90 | 89 | 88.9 | 98.9 | 111.3 | *** | 90 | 80.6 | 73.0 | 90.5 | *** | 85 | 21.6 | 10.6 | 49.2 | *** |
| 100 | 357 | 54.5 | 90.4 | 165.9 | *** | 360 | 57.1 | 68.4 | 119.7 | *** | 340 | 29.3 | 21.9 | 74.6 | *** |
| 120 | 89 | 61.2 | 74.6 | 121.9 | *** | 90 | 59.3 | 51.0 | 86.1 | *** | 85 | 22.4 | 14.3 | 63.8 | *** |
| 130 | 268 | 31.9 | 40.6 | 127.3 | *** | 270 | 39.1 | 39.9 | 102.1 | *** | 255 | 11.3 | 6.4 | 57.0 | *** |
| 140 | 267 | 25.6 | 32.7 | 127.4 | *** | 270 | 33.5 | 42.8 | 127.8 | *** | 255 | 14.9 | 9.0 | 60.5 | *** |
| 150 | 358 | 31.6 | 44.6 | 141.0 | *** | 360 | 37.3 | 51.2 | 137.2 | *** | 340 | 28.3 | 30.4 | 107.3 | ** |
| 160 | 89 | 42.3 | 51.4 | 121.6 | *** | 90 | 50.4 | 63.8 | 126.6 | *** | 85 | 24.5 | 11.3 | 46.2 | *** |
| 180 | 90 | 65.1 | 75.1 | 115.3 | *** | 90 | 77.4 | 71.2 | 92.0 | *** | 85 | 35.3 | 12.7 | 36.1 | *** |
| 190 | 89 | 22.3 | 27.1 | 121.5 | *** | 90 | 31.9 | 30.3 | 95.0 | *** | 85 | 15.1 | 10.3 | 67.9 | *** |
| 200 | 179 | 25.2 | 29.1 | 115.8 | *** | 180 | 33.8 | 41.9 | 124.2 | *** | 170 | 13.6 | 8.6 | 63.2 | *** |

NoMag = no magnification; mag = magnification; CV% = coefficient of variation; NS = not significant.
***$P < .001$.

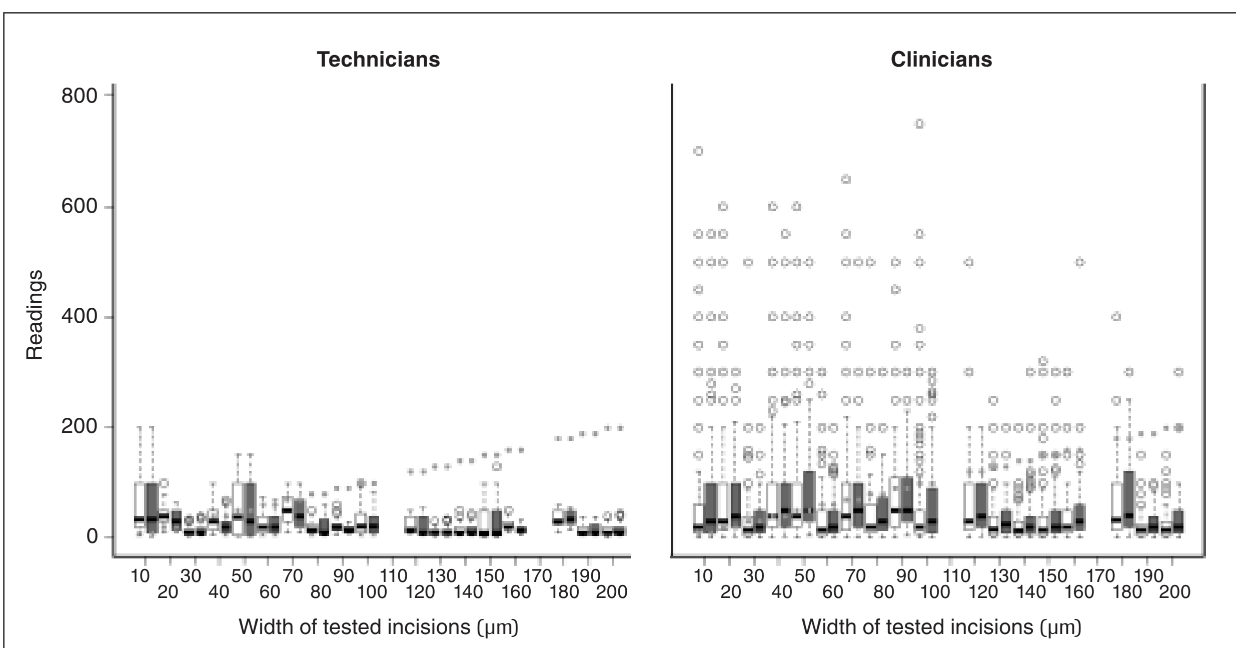


**Fig 1** Distribution of readings with (gray bars) and without (white bars) magnification in comparison to the real values for technicians and clinicians groups.

| | Technicians (MAG) | | | |
|---|---|---|---|---|
| N | Mean | SD | CV% | *P* |
| 255 | 61.2 | 60.0 | 98.0 | *** |
| 170 | 34.2 | 17.6 | 51.5 | *** |
| 170 | 12.8 | 8.2 | 64.2 | *** |
| 170 | 24.4 | 16.3 | 66.8 | *** |
| 170 | 49.4 | 47.2 | 95.6 | NS |
| 340 | 26.4 | 19.2 | 72.5 | *** |
| 170 | 44.3 | 26.5 | 60.1 | *** |
| 170 | 19.7 | 14.5 | 73.4 | *** |
| 85 | 15.4 | 5.2 | 33.9 | *** |
| 340 | 28.8 | 21.0 | 72.8 | *** |
| 85 | 22.6 | 16.9 | 74.7 | *** |
| 255 | 11.5 | 7.5 | 65.5 | *** |
| 255 | 13.9 | 8.6 | 62.0 | *** |
| 340 | 28.2 | 32.0 | 113.2 | *** |
| 85 | 16.3 | 7.3 | 44.7 | *** |
| 85 | 36.2 | 11.7 | 32.5 | *** |
| 85 | 15.4 | 9.6 | 62.6 | *** |
| 170 | 15.0 | 10.3 | 69.0 | *** |

Data were first analyzed for normality with the Kolmogorov-Smirnov test and with the Bartlett test for the equality of variances. As readings were not normally distributed and data were heteroscedastic, the Kruskal-Wallis analysis of variance and the Wilcoxon test were applied to assess the significance of the differences among the operators and between readings with and without magnification. All analyses were processed using R 2.15.2 software (The R Project for Statistical Computing, University of Auckland). The level of significance was set at $P < .05$.

## Results

The descriptive analysis of the 14,000 collected measurements showed a wide variation of results, ranging from 0 to 750 µm for the clinician group and from 0 to 200 µm for the technician group. For clinicians, high coefficients of variation were registered both with and without magnification; however, data variability was higher when no magnification was used. Conversely, comparable coefficients of variation were observed in the technician group, independent of the magnification aid (Table 1). Statistical analysis confirmed that reading accuracy was operator-dependent, as the Kruskal-Wallis test highlighted significant differences between readers in both the clinician and technician groups ($P < .001$). Reading accuracy improved with optical magnification only for clinicians as determined by Wilcoxon test (Fig 1). There was no relationship between the error of readings and years of experience (Fig 2).

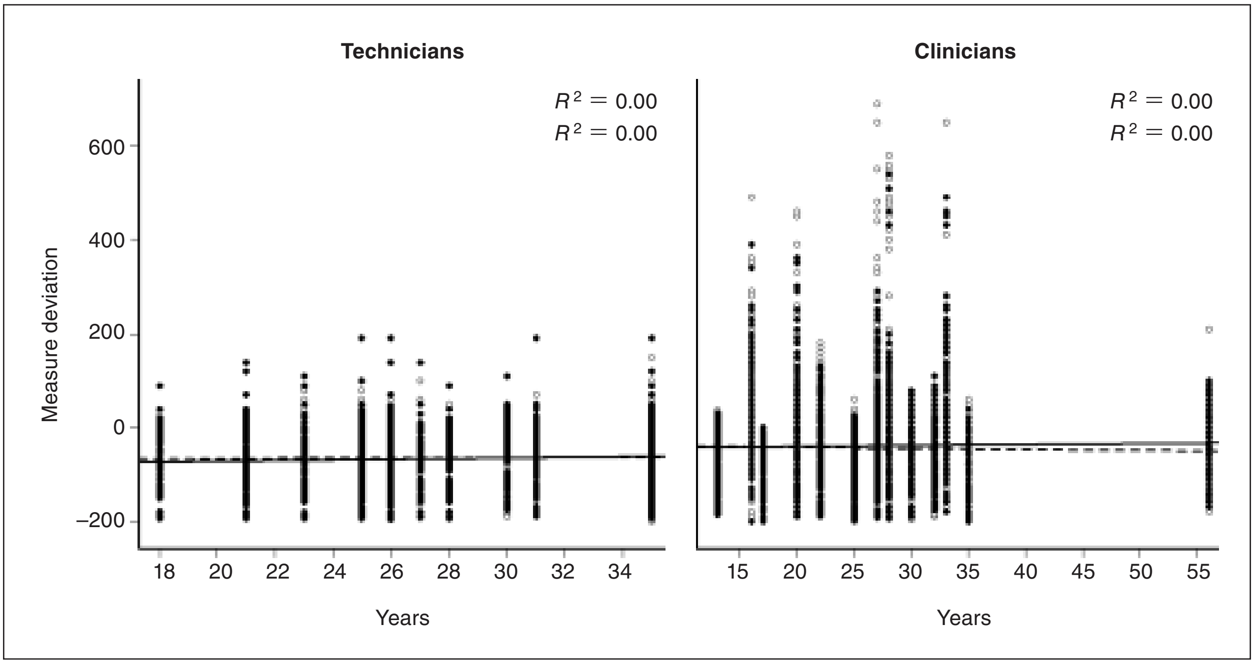


**Fig 2** Measure deviation from real values in relation to the operator's years of experience.

## Discussion

In this study, visual examination was not a reliable procedure to determine the width of incisions simulating marginal gaps. Reading accuracy was operator-dependent; thus, the first null hypothesis could be rejected. The sensitivity and specificity of the visual test improved with the use of optical aids only for the clinician group; thus, the second null hypothesis could also be rejected.

The precision of readings was better for technicians than for clinicians. The practice of technicians to work in more friendly conditions than the oral cavity may presumably explain their enhanced accuracy. The potential discrepancies existing between the working model and the clinical situation relativize the feedback of dental technicians, needing a clinical validation that takes place in a less than ideal environment. In fact, several factors (illumination, indirect vision, saliva, crevicular fluid, cheeks, tongue) affect the evaluation.

Due to a lack of technology that would make possible the transfer of a perfect replica from the laboratory to the clinical situation, a valid and widespread method of direct clinical measurement is missing.

## Conclusion

In this research, an improvement in the ability to detect open margins during subsequent readings was reported. Specific training may improve the operator's ability to detect marginal gaps.

## Acknowledgments

The authors reported no conflicts of interest related to this study.

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*Literature Abstract*

**A retrospective evaluation of teeth restored with zirconia ceramic posts: 10-year results**

This study retrospectively reviewed 64 posts in 45 patients for a mean observation period of 10 years. The posts were distributed between CeraPost (Brasseler) zirconia posts (n = 134) and CosmoPost (Ivoclar Vivadent) zirconia posts (n = 7). Either ceramic or direct composite cores were built onto the posts with the posts adhesively luted after air abasion with alumina particles or silica coating and silanization. Most of the restored teeth were abutments for metal ceramic or ceramic fixed dental prostheses. The success criteria were defined as: *(1)* lack of tooth sensitivity to horizontal and vertical percussion tests, *(2)* probing depths of ;26; 3 mm at six aspects, *(3)* lack of mobility of the crown and/or post, and *(4)* lack of periapical radiolucency. Results showed that the mean survival probability for teeth with zirconia posts was 81.3% after an observation period of 10 years. The authors reported a dropout rate of 49.4% (44 patients). The most common failure was extraction of the restored tooth. The small number of failures did not allow the authors to perform a statistical evaluation of the data according to the influence of covariables, such as post diameter, arch, tooth type, and type of prosthesis. The authors concluded that the 10-year survival probability of teeth restored with zirconia posts was comparable to the literature on teeth restored with other post materials but cautioned the implication of this finding due to the high patient dropout rate.

**Bateli M, Kern M, Wolkewitz M, Strub JR, Att W.** *Clin Oral Investig* 2013 Jul 31 [epub ahead of print]. **References:** 34. **Reprints:** M Bateli, Department of Prosthodontics, School of Dentistry, Albert-Ludwigs University, Hugstetter Strasse 55, 79106 Freiburg, Germany. Email: maria.bateli@uniklinik-freiburg.de —*John Chai, Evanston, Illinois, USA.*