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Marginal and Internal Fit of Different Fixed Dental Prostheses: A Comparative Study

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Abstract

Introduction: Numerous studies have previously evaluated the marginal and internal fit of fixed prostheses; however, few reports have performed an objective comparison of the various methods used for their assessment. The purpose of this study was to compare five marginal and internal fit assessment methods for fixed prostheses.
Material And Methods: A specially designed sample was used to measure the marginal and internal fit of the prosthesis according to the cross-sectional method (CSM), silicone replica technique (SRT), triple scan method (TSM), micro-computed tomography (MCT), and optical coherence tomography (OCT).
Results: The five methods showed significant differences in the four regions that were assessed ($p < 0.001$). The marginal, axial, angle, and occlusal regions showed low mean values: CSM (23.2 µm), TSM (56.3 µm), MCT (84.3 µm), and MCT (102.6 µm), respectively. The marginal fit for each method was in the range of 23.2–83.4 µm and internal fit (axial, angle, and occlusal) ranged from 44.8–95.9 µm, 84.3–128.6 µm, and 102.6–140.5 µm, respectively.
Conclusion: The marginal and internal fit showed significant differences depending on the method. Even if the assessment values of the marginal and internal fit are found to be in the allowable clinical range, the differences in the values according to the method should be considered.
Keywords: Marginal And Internal Fit; Dentistry; Dental Prosthesis

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Introduction

The marginal fit of a fixed prosthesis is one of the most important factors for successful prosthetic treatment [1,2]. An ideal marginal fit maintains a healthy periodontal status and prevents cement dissolution [3,4]. On the other hand, a poor marginal fit has a negative impact on the periodontium, making it difficult to perform long-term maintenance of the patient's health following implant placement [5–7]. In addition, an excellent internal fit increases the retention of the prosthesis [8]. For these reasons, numerous studies have been conducted on the marginal and internal fit of a prosthesis to determine its prognosis [1–3].Previous studies have compared the accuracy of methods for analyzing the marginal and internal fit measurements of fixed prostheses. However, since the objective of the previous studies was to increase the reliability of the assessment method, they only compared two methods to identify an appropriate approach, rather than comparing the various existing methods.With the recent advances in computer-aided design and computer-aided manufacturing (CAD-CAM) systems, the marginal gap of the prosthesis is a very low value within 100 µm, while most of the literature reports the clinically allowable marginal gap to be within a range of 100–120 µm. Several previous studies have assessed the fitness of fixed prostheses based on this clinically allowable range, but if there are differences in the resulting values based on the assessment method used, an objective comparison is difficult. Thus, for precise measurement, it is necessary to verify the differences between the various methods recently presented.In this study, in order to verify the differences through an objective comparison of five evaluation methods, the marginal and internal fit were measured in cross-sectional images obtained from the sample under identical conditions. This study aimed to conduct a comparative assessment of the marginal and internal fit methods introduced in previous studies (CSM, SRT, TSM, MCT, and OCT). A null hypothesis was set as follows: there would be no differences in the marginal and internal (axial, angle, and occlusal region) fit measured according to the CSM, SRT, TSM, MCT, and OCT assessment methods.

Materials and Methods

This study measured the marginal and internal fit of the prosthesis according to the five methods. The analysis guide template was used to obtain a cross-sectional image of the same part in each analysis method. Four regions (marginal gap, axial gap, angle gap, and occlusal gap) were measured on the four sides (buccal, lingual, mesial, and distal) of the prosthesis, and the gaps were measured at 10 points on each side. Thus, 40 points were measured for each region (marginal, axial, angle, and occlusal) (n = 40). A pilot experiment was conducted five times, and the calculation was made using a power analysis software. All gap measurements were made by the same researcher. Since the researcher's expertise could greatly impact the accuracy of the prosthesis fitness evaluation, assessments were conducted only after substantial training and practice. A specially designed sample was used to measure the marginal and internal fit of the prosthesis according to the cross-sectional method (CSM), silicone replica technique (SRT), triple scan method (TSM), micro-computed tomography (MCT), and optical coherence tomography (OCT).All data were analyzed using SPSS statistical software using the appropriate tools and the p value<0.05 was considered significant.

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Results

The values from the measurements for the marginal and internal fit are shown in Table1. There were statistically significant differences in the fitness of the margin region among the five methods ($p < 0.001$). CSM (23.2 ± 5.3 µm) and SRT (33.5 ± 12.1 µm) did not differ significantly ($p = 0.014$) and showed the lowest value. Similarly, there were no statistically significant differences ($p = 0.227$) between TSM (74.1 ± 26.1 µm) and OCT (83.4 ± 22.1 µm), but they showed the highest values. Furthermore, MCT (45.9 ± 25.9 µm) did not have statistically significant differences compared to SRT ($p = 0.090$).Some of the five methods showed statistically significant differences ($p < 0.001$) in the fitness of the axial region. CSM (83.7 ± 19.8 µm) and SRT (95.9 ± 52.9 µm) did not have statistically significant differences ($p = 0.760$) but demonstrated the highest values. On the other hand, although TSM (56.3 ± 30.1 µm), MCT (65.3 ± 47.7 µm), and OCT (44.8 ± 14.5 µm) did not have statistically significant differences ($p > 0.005$), they showed the lowest values.Also, some of the five methods showed statistically significant differences ($p < 0.001$) in the fitness of the angle region. CSM (87.9 ± 17.2 µm) and MCT (84.3 ± 20.2 µm) did not have statistically significant differences ($p = 0.651$) and showed the lowest values. TSM (110.1 ± 13.9 µm) and OCT (118.2 ± 22.2 µm) also did not have statistically significant differences ($p = 0.163$), but they showed the highest values. Lastly, SRT (128.6 ± 17.3 µm) did not have statistically significant differences from OCT ($p = 0.043$).There were some statistically significant differences ($p < 0.001$) in the fitness of the occlusal region between the five methods. CSM (125.4 ± 13.7 µm), SRT (140.5 ± 33.3 µm), TSM (120.3 ± 20.9 µm), and OCT (134 ± 18.9 µm) did not have statistically significant differences ($p > 0.005$), showing the highest values. On the other hand, MCT (102.6 ± 12.8 µm) showed the lowest value.Figure 1 shows the difference of each method from CSM. Except for the angle region, the SRT showed the most approximate value.

Table 1. The marginal and internal gap of the cross-sectional method (CSM), silicone replica technique (SRT), triple scan method (TSM), micro-computed tomography (MCT), and optical coherence tomography (OCT). Gap values are depicted as mean (µm) ± standard deviation (SD)

Test method	Margin	Axial	Angle	Occlusal
CSM	23.2 ± 5.3 ^{a}	83.7 ± 19.8 ^{a}	87.9 ± 17.2 ^{a}	125.4 ± 13.7 ^{a}
SRT	33.5 ± 12.1 ^{a,b}	95.9 ± 52.9 ^{a,b}	128.6 ± 17.3 ^{b}	140.5 ± 33.3 ^{a}
TSM	74.1 ± 26.1 ^{c}	56.3 ± 30.1 ^{c}	110.1 ± 13.9 ^{c}	120.3 ± 20.9 ^{a}
MCT	45.9 ± 25.9 ^{b}	65.3 ± 47.7 ^{c,b}	84.3 ± 20.2 ^{a}	102.6 ± 12.8 ^{b}
OCT	83.4 ± 22.1 ^{c}	44.8 ± 14.5 ^{c}	118.2 ± 22.2 ^{b,c}	134 ± 18.9 ^{a}

Figure 1. Differences in values compared to the cross-sectional method (CSM). The graph shows the difference from each method based on the CSM (baseline).

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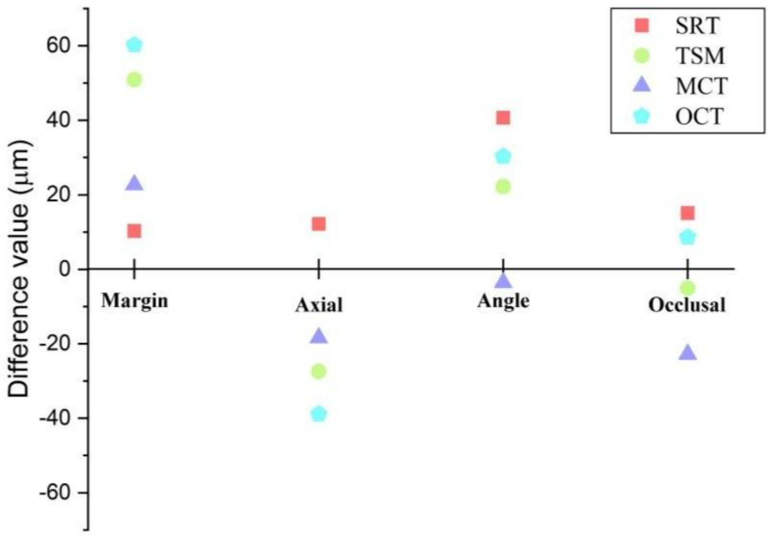

Discussion

The results of this study showed differences in the values obtained from the five types of marginal and internal fit assessment methods. In addition, there was a tendency to obtain similar marginal and internal fit measurements in CSM and SRT, and in TSM and OCT.In previous studies, in order to verify these differences, Oka et al. [14] produced a silicone replica by mixing a contrast medium with silicone and found that there were no significant differences in all the regions measured using MCT and SRT. On the other hand, the results of a comparison of MCT and SRT in our study did not show significant differences in the marginal and axial regions, but there were significant differences in the angle and occlusal regions in SRT with a high value. The previous studies also showed different results based on the methods. The differences between our study and the previous studies are as follows. This study produced and applied a guide template to conduct analysis at the same position in the 2D image and made a comparison with the gap value of 40 points per region in a sample. The study was conducted with one sample to minimize production errors (e.g., study model, template, and coping) and to only observe the differences between methods. In addition, the previous studies compared two methods, while this study compared the most possible methods used for assessing the fitness of the fixed prosthesis. Thus, through the results of our study, the differences in the result values based on the method could be compared.A poor marginal fit can increase plaque accumulation leading to secondary caries, periodontal disease, and endodontic inflammation. Our study compared the marginal and internal fit methods, and according to the methods, the marginal fit was 23.2–83.4 µm (a 60.2 µm difference), and the internal fit (axial, angle, and occlusal) was 44.8–95.9 µm (a 51.1 µm difference), 84.3–128.6 µm (a 44.3 µm difference), and 102.6–140.5 µm (a 37.9 µm difference), respectively. If the marginal fit of a certain restoration material shows a clinical allowable result of about 60 µm using the SRT method, the result may deviate from the clinical allowable range using the OCT method. In contrast, even though the result is not in the clinical allowable range, it may be altered by changing the assessment method.In previous studies, the CSM method and SRT method [5,14] showed higher reliability than the other methods. Our results of the marginal fit analysis by SRT were similar to that of CSM and MCT. Also, the results of the internal fit analysis by SRT were similar to CSM and MCT in the axial gap; OCT in the angle gap; and CSM and OCT in the occlusal gap. Overall, SRT shows a similar tendency to CSM. From an economic point of view, OCT, MCT, and TSM require expensive equipment operated by experts along with the analysis software. SRT and CSM, on the other hand, have the merits of being relatively easy and low-cost methods. In addition to the methods examined in our study, there are many fitness assessment methods that have been applied by others [14]. The assessment methods used in varying conditions and the lack of standardization could lead to false interpretations and thus limit their comparison with the results of other studies. However, our study made measurements using individual measuring devices, software, and by using methods proposed in previous studies in order to represent each assessment method. Therefore, it is recommended that future studies should compare our method with the methods proposed in other studies.

Conclusions

In our findings, there was a tendency of having similar marginal and internal fit in CSM and SRT, and in TSM and OCT. Therefore, the relatively simple and inexpensive SRT method can be an excellent alternative to CSM. According to the significance of these results, even if the assessment result values of the marginal and internal fit are in the clinical allowable range, the differences in the result values according to the method should be considered.

References

1. Kim, D.Y.; Kim, J.H.; Kim, H.Y.; Kim, W.C. Comparison and evaluation of marginal and internal gaps in cobalt–chromium alloy copings fabricated using subtractive and additive manufacturing. J. Prosthodont. Res.**2018**, 62, 56–64. [CrossRef]
2. Akçin, E.T.; Güncü, M.B.; Aktas¸, G.; Aslan, Y. Effect of manufacturing techniques on the marginal and internal fit of cobalt-chromium implant-supported multiunit frameworks. J. Prosthet. Dent. **2018**, 120, 715–720. [CrossRef] [PubMed]
3. Dauti, R.; Cvikl, B.; Lilaj, B.; Heimel, P.; Moritz, A.; Schedle, A. Micro-CT evaluation of marginal and internal fit of cemented polymer infiltrated ceramic network material crowns manufactured after conventional and digital impressions. J. Prosthodont. Res. **2018**, 63, 40–46. [CrossRef] [PubMed]
4. Alharbi, N.; Alharbi, S.; Cuijpers, V.M.; Osman, R.B.; Wismeijer, D. Three-dimensional evaluation of marginal and internal fit of 3D-printed interim restorations fabricated on different finish line designs. J. Prosthodont. Res. **2018**, 62, 218–226. [CrossRef]
5. Ariganello, M.B.; Guadarrama Bello, D.; Rodriguez-Contreras, A.; Sadeghi, S.; Isola, G.; Variola, F.; Nanci, A. Surface nanocavitation of titanium modulates macrophage activity. Int. J. Nanomed. **2018**, 13, 8297–8308. [CrossRef] [PubMed]
6. Hagenfeld, D.; Mutters, N.T.; Harks, I.; Koch, R.; Kim, T.S.; Prehm, P. Hyaluronan-mediated mononuclear leukocyte binding to gingival fibroblasts. Clin. Oral Investig. **2018**, 22, 1063–1070. [CrossRef]
7. Matarese, G.; Ramaglia, L.; Fiorillo, L.; Cervino, G.; Lauritano, F.; Isola, G. Implantology and Periodontal Disease: The Panacea to Problem Solving? Open Dent. J. **2017**, 11, 460–465. [CrossRef]
8. Martins, L.M.; Lorenzoni, F.C.; Melo, A.O.D.; Silva, L.M.D.; Oliveira, J.L.G.D.; Oliveira, P.C.G.D.; Bonfante, G. Internal fit of two all-

ceramic systems and metal-ceramic crowns. J. Appl. Oral Sci. **2012**, 20, 235–240. [CrossRef]
9. Sundar, M.K.; Chikmagalur, S.B.; Pasha, F. Marginal fit and microleakage of cast and metal laser sintered copings-An in vitro study. J. Prosthodont. Res. **2014**, 58, 252–258. [CrossRef]
10. Farronato, D.; Pieroni, S.; Mangano, F.G.; Briguglio, F.; Re, D. Effects of different abutment material and surgical insertion torque on the marginal adaptation of an internal conical interface: An in vitro study. J.Prosthodont. Res. **2014**, 58, 230–236. [CrossRef]
11. Sachs, C.; Groesser, J.; Stadelmann, M.; Schweiger, J.; Erdelt, K.; Beuer, F. Full-arch prostheses from translucent zirconia: Accuracy of fit. Dent. Mater. **2014**, 30, 817–823. [CrossRef]
12. Acquaviva, P.; Madini, L.; Nembrini, E.; Brazzoli, S.; Papacchini, F.; Cerutti, F.A. Marginal adaptation of new bulk fill composites: Microscopical evaluation. Dent. Mater. **2014**, 30, e125. [CrossRef]
13. Park, S.; Jung, J.; Han, S. Internal and marginal adaptation of bulk-filled composites. Dent. Mater. **2015**, 31, e17–e18. [CrossRef]
14. Oka, Y.; Sasaki, J.I.; Wakabayashi, K.; Nakano, Y.; Okamura, S.Y.; Nakamura, T.; Imazato, S.; Yatani, H. Fabrication of a radiopaque fit-testing material to evaluate the three-dimensional accuracy of dental prostheses. Dent. Mater. **2016**, 32, 921–928. [CrossRef]
15. Rezende, C.E.E.; Borges, A.F.S.; Macedo, R.M.; Rubo, J.H.; Griggs, J.A. Dimensional changes from the sintering process and fit of Y-TZP copings: Micro-CT analysis. Dent. Mater. **2017**, 33, e405–e413. [CrossRef]
16. Monteiro, G.Q.; Montes, M.A.; Gomes, A.S.; Mota, C.C.; Campello, C.C.; Freitas, A.Z. Marginal analysis of resin composite restorative systems using optical coherence tomography. Dent. Mater. **2011**, 27, e213–e223. [CrossRef]
17. Makishi, P.; Thitthaweerat, S.; Sadr, A.; Shimada, Y.; Giannini, M.; Tagami, J.; Sumi, Y. Marginal adaptation of different adhesive systems to dentin by optical coherence tomography. Dent. Mater. **2013**, 29, e46. [CrossRef]
18. Sadr, A.; Shimada, Y.; Bista, B.; Makishi, P.; Sumi, Y.; Tagami, J. Comparison of tomographic techniques for assessment of marginal and internal microgaps of composites. Dent. Mater. **2013**, 29, e55–e56. [CrossRef]
19. Comba, A.; Ventura, G.; Luganini, A.; Alovisi, M.; Alovisi, C.; Berutti, E.; Scotti, N. OCT evaluation of marginal seal of bulk-fill composites in dentin. Dent. Mater. **2015**, 31, e42. [CrossRef]
20. Comba, A.; Tempesta, R.M.; Ventura, G.; Luganini, A.; Alovisi, C.; Berutti, E.; Scotti, N. Marginal adaptation of composites on dentin with different imaging techniques. Dent. Mater. **2016**, 32, e74. [CrossRef]
21. Han, S.H.; Sadr, A.; Tagami, J.; Park, S.H. Non-destructive evaluation of an internal adaptation of resin composite restoration with swept-source optical coherence tomography and micro-CT. Dent. Mater. **2016**, 32, e1–e7. [CrossRef]
22. Kim, K.B.; Kim, W.C.; Kim, H.Y.; Kim, J.H. An evaluation of marginal fit of three-unit fixed dental prostheses fabricated by direct metal laser sintering system. Dent. Mater. **2013**, 29, e91–e96. [CrossRef]
23. Colpani, J.T.; Borba, M.; Della Bona, Á. Evaluation of marginal and internal fit of ceramic crown copings.

24. Dent. Mater. **2013**, 29, 174–180. [CrossRef]
25. Keul, C.; Stawarczyk, B.; Erdelt, K.J.; Beuer, F.; Edelhoff, D.; Güth, J.F. Fit of 4-unit FDPs made of zirconia and CoCr-alloy after chairside andlabside digitalization–a laboratory study. Dent. Mater. **2014**, 30, 400–407. [CrossRef] [PubMed]
26. Piras, F.; Berro-Filho, J.; Rubo, J.; Ferruzzi, F.; Ferrairo, B.; Mosquim, V. Marginal and internal space of metallic copings. Dent. Mater. **2016**, 32, e75. [CrossRef]
27. Schriwer, C.; Skjold, A.; Gjerdet, N.R.; Øilo, M. Monolithic zirconia dental crowns. Internal fit, margin quality, fracture mode and load at fracture. Dent. Mater. **2017**, 33, 1012–1020. [CrossRef]
28. Schaefer, O.; Watts, D.C.; Sigusch, B.W.; Kuepper, H.;Guentsch, A. Marginal and internal fit of pressed lithium disilicate partial crowns in vitro: A three-dimensional analysis of accuracy and reproducibility. Dent. Mater. **2012**, 28, 320–326. [CrossRef]
29. Schaefer, O.; Kuepper, H.; Thompson, G.A.; Cachovan, G.; Hefti, A.F.; Guentsch, A. Effect of CNC-milling on the marginal and internal fit of dental ceramics: A pilot study. Dent. Mater. **2013**, 29, 851–858. [CrossRef]