ISSN: 2835-7914

Original Article

Biomedical Science and Clinical Research

What is the Impact of Impression Techniques on the Marginal Adaptation of Metal-Ceramic Crowns Fabricated by Direct Metal Laser-Sintering

Ibrahim Al-Ibrahim[1], Ebtisam Salameh[1] and Obada Jabbour[2*]

[1]*Department of Prosthodontics, Faculty of Dentistry, University of Hama, Syrian Arab Republic*

[2]*Department of Pediatric Dentistry, Faculty of Dentistry, University of Hama, Syrian Arab Republic*

***Corresponding Author**
Obada Jabbour, Department of Pediatric Dentistry, Faculty of Dentistry, University of Hama, Syrian Arab Republic.

Submitted: 2023, May 05 **Accepted:** 2023, Jun 02 **Published:** 2023, Jun 08

Citation: Ibrahim, I. A., Jabbour, O., Salameh, E. (2023). What is the Impact of Impression Techniques on the Marginal Adaptation of Metal-Ceramic Crowns Fabricated by Direct Metal Laser-Sintering. *Biomed Sci Clin Res, 2*(2), 215-220.

Abstract

Introduction: *Studies on Marginal adaptation of restorations fabricated by direct metal laser-sintering DMLS are limited. This study to evaluate the effect of two impression techniques on the marginal adaptation of metal ceramic crowns fabricated by DMLS.*

Materials and Methods: *Twenty intact maxillary premolars extracted for orthodontics reasons were received metal-ceramic crowns. After preparation according to the preparation guidelines for metal-ceramic crowns, the teeth were divided into two groups according to impression techniques (n=10): (1) group A IOS impression, (2) group B conventional impression. Group A specimens were scanned using IOS (I 500, MEDIT, Korea). Whereas, a custom-made tray used to make putty-wash impression to the specimens of group B. Group B casts were scanned using extraoral scanner (Identica T300, META, Korea). The metal coping designs were transferred to a direct metal laser-sintering (MYSINT100, SISMA, Italy), and they were made from Co-Cr blocks. The marginal adaptation was measured at labial, palatal, misael, and distal surfaces using microscope (Olympus, Japan). Student's paired t test was used to assess the marginal adaptation between the groups. The cutoff value for statistical significance was set at $\alpha = 0.05$.*

Results: *A statistically significant differences in marginal adaptation was found between the impression techniques for all evaluations (labial, palatal, misael, and distal) ($P<0.05$). The lowest values were recorded with IOS impression in all surfaces.*

Conclusions: *the marginal adaptation values of IOS impression exhibited an acceptable marginal fit of less than 120 µm.*

Keywords: Marginal Adaptation, Oral Scanner, Metal-Ceramic Crowns

1. Introduction

Marginal adaptation is an essential factor in determining the longevity of fixed prostheses [1]. Improper marginal adaptation can cause microleakage recurrent caries cement dissolution and gingival problems [2-5]. According to the authors, the ideal maximum marginal discrepancy for indirect restoration success and longevity is 100 µm [6]. However, McLean and von Fraunhofer considered a marginal discrepancy value of 120 µm acceptable in clinical practice [7].

Currently, the introduction of CAD/CAM methods have provided breakthroughs in the fabrication of fixed partial denture [8]. The advantage of these techniques is that the restorations can be produced in a short time and standardizes the production of restorations [9,10]. The developments have also been included metal framework production technologies [11]. The direct metal laser-sintering (DMLS) is a metal fabrication system fabricates complicated shapes in short working time [12]. During the fabrication of metal core, the metal powder is shot selectively based on data received from 3D CAD, and then fused with laser [12].

In conjunction with these developments, intraoral scanner IOS was developed for dental practice to overcome difficulties associated with conventional impressions techniques [13]. Gjelvold et al. indicated that IOS impression more comfortable than conventional one [14].

Based on previous advances in digital dentistry, and since metal ceramic prostheses are still the most commonly fixed partial dentures, the aim of this in vitro study was to evaluate the effect of two impression techniques on the marginal adaptation of metal ceramic crowns fabricated by DMLS. The null hypothesis was that impression technique have no effect on the marginal adaptation of metal ceramic crowns.

2. Methods

This study was approved by the Research Ethics Committee of the Faculty of Dentistry – University of Hama, Hama, Syrian Arab Republic.

3. Specimens' Preparation

A 20 intact maxillary premolars extracted for orthodontics reasons were received metal-ceramic crowns. Each tooth was set within an acrylic bloke using planning device (Emmevi, Italy) and the longitudinal axis of the tooth is perpendicular to the surface of the acrylic bloke, the cemento-enamel junction was 2 mm above the surface of the acrylic bloke.

A circumferential semi-chamfer margin (1 mm in width) and occlusal reduction of 1.5 to 2 mm was prepared according to the preparation guidelines for metal-ceramic crowns. the planning device was used to set speed handpiece (NSK, Japan) to ensure uniform thickness of the preparation (figure 1).

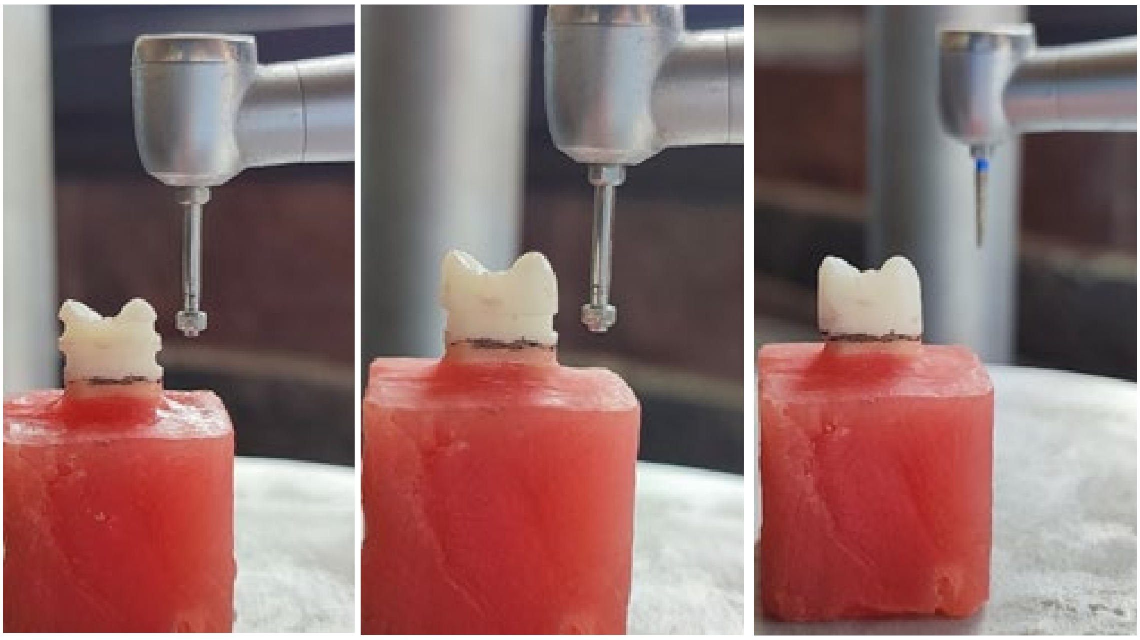

Figure 1: Preparation of Specimens

4. Impression Techniques

The teeth were divided into two groups according to impression techniques (n=10): (1) group A IOS impression, (2) group B conventional impression. Group A specimens were scanned using IOS (I 500, MEDIT, Korea) (figure 2). Whereas, ten putty-wash impressions were made with a impression material (Imflex; META BIOMED, Korea) in a custom-made tray to the specimens of group B. after that the casts were scanned using extraoral scanner (Identica T300, META, Korea) (figure 3).

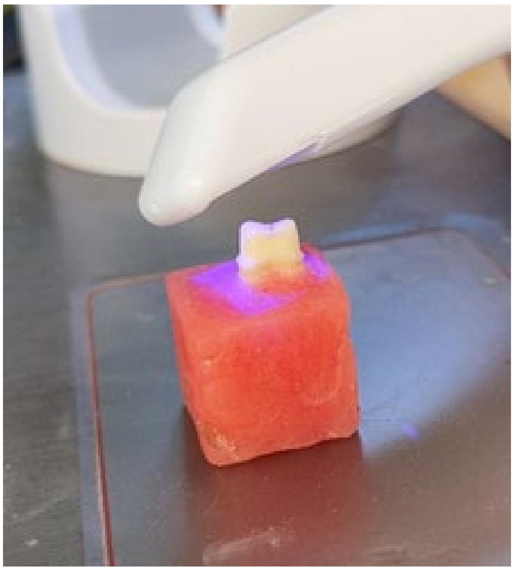

Figure 2: Scanning Specimens Using IOS

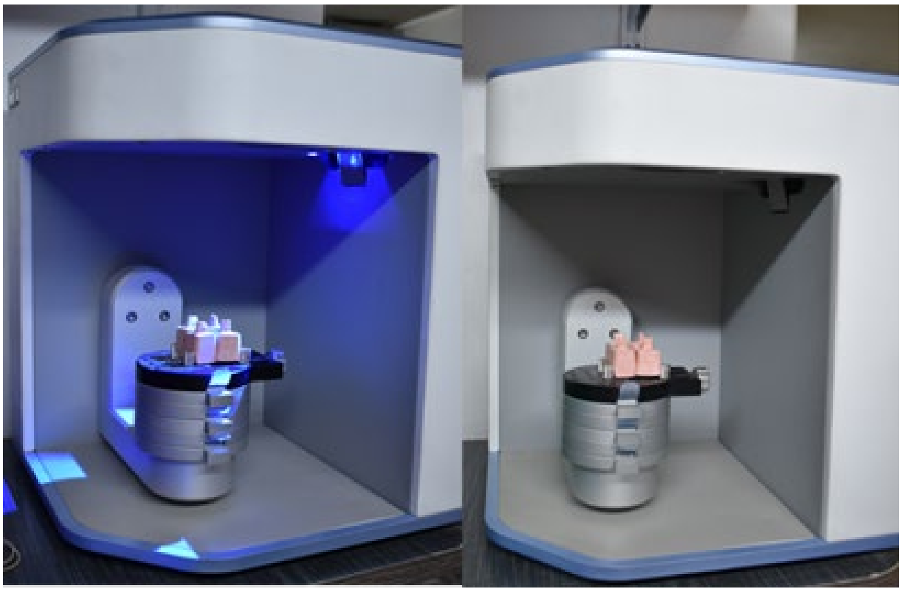

Figure 3: Scanning Casts Using Extraoral Scanner

5. Metal Copings Production and Marginal Adaptation Measurements

To produce the metal copings using the DMLS technique, all digital images were transferred to a computer. The metal copings were designed with software (exocad) (figure 4). The metal coping designs were transferred to a direct metal laser-sintering (MYSINT100, SISMA, Italy), and they were made from Co-Cr blocks (Starbond CoS Powder 30, SCHENFTNER, Germany). To rest stress, the metal copings were set in an annealing oven (Nobertherm, Germany) under 1250 ℃ for 7 hours. Finally, the metal copings were adhesive to the teeth using glass ionomer cement (CAVEX, Germany). The marginal adaptation was measured at randomized three points in each axial surfaces using microscope (Olympus, Japan) (figure 5).

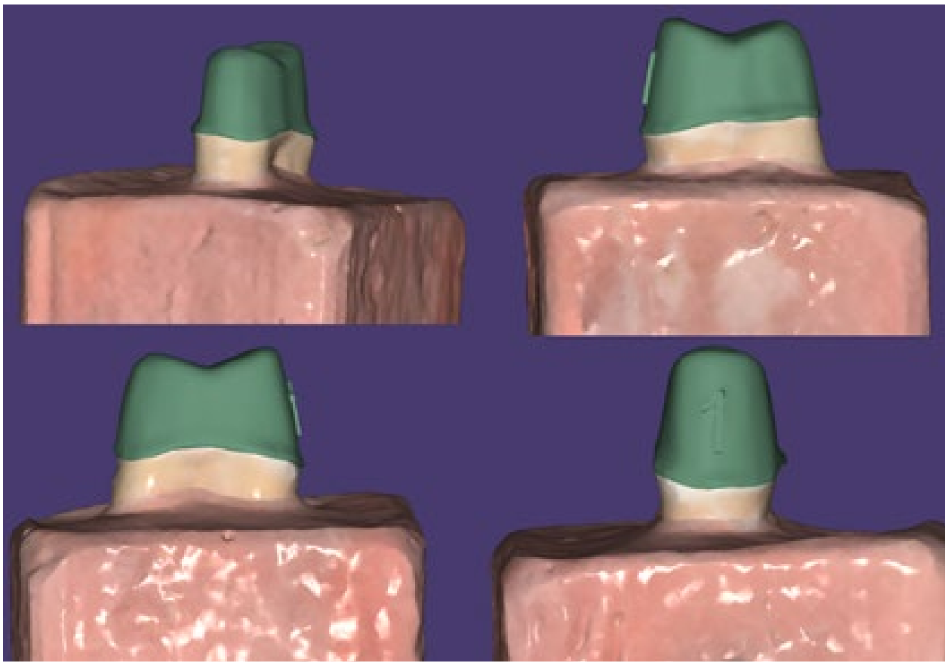

Figure 4: Metal Copings Design

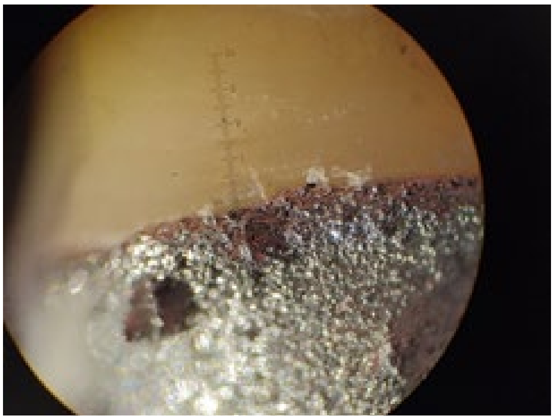

Figure 5: Measurement Of Marginal Adaptation

6. Statistical Analysis

Data that were obtained were analyzed using the statistical software IBM SPSS version 25 (SPSS, Inc., Chicago, IL, USA), marginal adaptation data were subjected to statistical analysis between impression techniques using Student's paired t test at a significance level of 0.05.

7. Result

The mean and standard deviation of the marginal adaptation for the metal ceramic crowns were listed in (Table 1). Table 2 show the results of Student's paired t test. A statistically significant differences in marginal adaptation was found between the impression techniques for all evaluations (labial, palatal, misael, and distal) ($P<0.05$). The lowest values were recorded with IOS impression in all surfaces, whereas the conventional impression on the distal surface exhibited the highest mean values in marginal adaptation (figure 6).

Measured surface	Impression techniques	
	IOS impression	Conventional impression
Labial surface	94.79 (6.94)	158.33 (7.33)
Palatal surface	73.96 (3.51)	160.42 (4.91)
Misael surface	88.55 (3.99)	163.54 (7.88)
Distal surface	89.58 (5.35)	227.08 (5.7)

Table 1: Mean (±SD) of the Marginal Adaptation (µm).

Measured surface	Independent samples T Test	
	T-value	P-value
Labial surface	-6.29	0.000
Palatal surface	-14.33	0.000
Misael surface	-8.49	0.000
Distal surface	-137.5	0.019

Table 2: Results of Student's Paired t test.

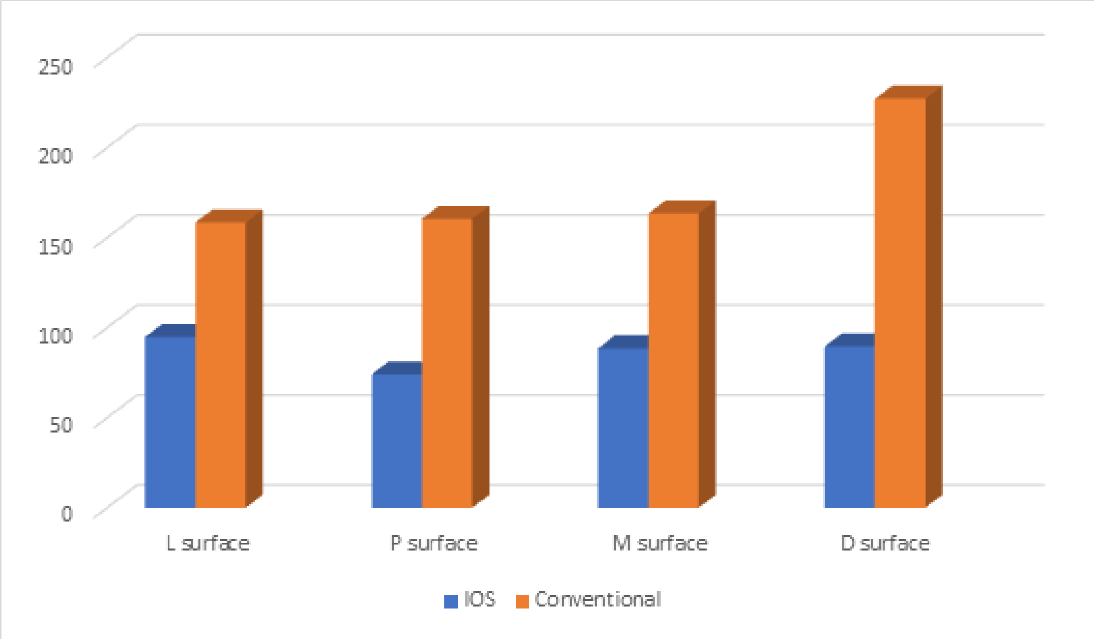

Figure 6: Marginal Adaptation Measurements

8. Discussion

This in vitro study evaluated marginal adaptation of metal-ceramic crowns. The results revealed a lower value of marginal adaptation in the IOS group. Therefore, the null hypothesis has been rejected that there were no significant differences in marginal adaptation among impression technique. Interestingly, all values recorded with conventional impression is above the acceptable value (120 μm) in clinical practice [7].

A study by Kokubo et al, revealed that maximum finger pressure is a reliable method to seat the restorations on the teeth, thus this method was used to seat the metal-ceramic crowns on the premolars in this in-vitro study [15]. To avoid differences between positional points, three points were measured on every surface of each abutment tooth. Wostmann et al, investigated the influence of the impression technique and material on in vivo marginal accuracy by extracting the teeth after impression making and measuring the marginal discrepancy under a microscope [16]. Using PVS impression material, they found discrepancies of 118 mm for the 2-step versus 128 mm for the 1-step technique. The 1-step technique was considered slightly inferior to the 2-step technique for subgingival margins. Based on this outcome, a 2-step technique was chosen for the conventional group in the current study.

To eliminating any possible variation in marginal gap, we used Co–Cr alloy for casting. The newly developed DMLS system is an additive metal fabrication technology, based on information received from three-dimensional CAD, in which metal powder is shot selectively using a data file and fused with a laser to laminate approximately a 20–60 m-thick layer with each shooting to complete a metal structure. There are multiple advantages of the DMLS system, the most important one that is showed inferiority in marginal fit [12].

The most reliability and precision method for measuring marginal adaptation of dental prostheses is the direct measuring method measures the gap or amount of cement directly by microscope after setting the dental prosthesis on the tooth model and incising it [17]. However, the direct measuring method has a critical problem of destroying the dental prosthesis and the tooth model [18].

This study revealed a mean marginal adaptation of 73.96 – 94.79 μm for the IOS impression group and 158.33 – 227.08 μm for the conventional impression group. These results agree with Syrek et al, who conducted an in vivo study to investigate the marginal fit of a ceramic single crown based on a digital impression (Lava COS) and a conventional impression, which reported 49 mm for the digital group and 71 mm for the conventional group–a significant difference [19].

Almeida et al, compared the fit of 4-unit ceramic FDPs between the intraoral digital method and the conventional impression method, revealing that marginal discrepancies were 63.96 μm for the digital group and 65.33 μm for the conventional group and that the values of internal discrepancies were 58.46 μm for the digital group and 65.94 μm for the conventional group. Similar to the results of Almeida et al. this study also suggested a lower value of marginal adaptation in the IOS group [20].

At present, no consensus exists on what constitutes a clinically acceptable maximum marginal gap width. Moreover, the systems and methodologies vary widely among the different studies. It is therefore difficult to directly compare the results among different studies. However, all studies seem to indicate predictable marginal adaptation within or close to the thresholds of clinical acceptability. It is interesting to observe that in Syrec's study, which also had a conventional impression as control, the intraoral impression system produced a better fit coinciding with our results [19].

Currently available intraoral digital systems work on various digital algorithmic principles, and these techniques have been proven able to create precise impressions directly from the oral cavity. However, this in vitro study neglected many clinical factors were present, including the location of the finish line, periodontal health, sulcal bleeding during impression making, saliva flow rate, and patient compliance.

More clinical studies are needed to establish the accuracy of digital impression in more extensive treatments in fixed prosthodontics, as well as for implant impressions.

9. Conclusion

Under the limitations of the present study, it may be concluded that the marginal adaptation values of IOS impression exhibited an acceptable marginal fit of less than 120 µm.

Acknowledgements

We have not received substantial contributions from non-authors.

Funding

This work was supported by University of Hama, Hama, Syrian Arab Republic.

Declarations of Interest: None

References

1. Şeker, E., Ozcelik, T. B., Rathi, N., & Yilmaz, B. (2016). Evaluation of marginal fit of CAD/CAM restorations fabricated through cone beam computerized tomography and laboratory scanner data. The Journal of Prosthetic Dentistry, 115(1), 47-51.
2. Contrepois, M., Soenen, A., Bartala, M., & Laviole, O. (2013). Marginal adaptation of ceramic crowns: a systematic review. The Journal of prosthetic dentistry, 110(6), 447-454.
3. Karlsson, S. (1986). A clinical evaluation of fixed bridges, 10 years following insertion. Journal of Oral Rehabilitation, 13(5), 423-432.
4. Cooper, T. M., Christensen, G. J., Laswell, H. R., & Baxter, R. (1971). Effect of venting on cast gold full crowns. The Journal of prosthetic dentistry, 26(6), 621-626.
5. Valderhaugw, J., & Birkeland, J. M. (1976). Periodontal conditions in patients 5 years following insertion of fixed prostheses: Pocket depth and loss of attachment. Journal of Oral Rehabilitation, 3(3), 237-243.
6. Fransson, B., Øilo, G., & Gjeitanger, R. (1985). The fit of metal-ceramic crowns, a clinical study. Dental Materials, 1(5), 197-199.
7. McLean, J. W. (1971). The estimation of cement film thickness by an in vivo technique. British dental journal, 131(3), 107-111.
8. Anadioti, E., Aquilino, S. A., Gratton, D. G., Holloway, J. A., Denry, I. L., Thomas, G. W., & Qian, F. (2015). Internal fit of pressed and computer-aided design/computer-aided manufacturing ceramic crowns made from digital and conventional impressions. The Journal of prosthetic dentistry, 113(4), 304-309.
9. Strub, J. R., Rekow, E. D., & Witkowski, S. (2006). Computer-aided design and fabrication of dental restorations: current systems and future possibilities. The Journal of the American Dental Association, 137(9), 1289-1296.
10. Kim, K. B., Kim, J. H., Kim, W. C., Kim, H. Y., & Kim, J. H. (2013). Evaluation of the marginal and internal gap of metal-ceramic crown fabricated with a selective laser sintering technology: two-and three-dimensional replica techniques. The journal of advanced prosthodontics, 5(2), 179-186.
11. Miyazaki, T., Hotta, Y., Kunii, J., Kuriyama, S., & Tamaki, Y. (2009). A review of dental CAD/CAM: current status and future perspectives from 20 years of experience. Dental materials journal, 28(1), 44-56.
12. Kim, K. B., Kim, W. C., Kim, H. Y., & Kim, J. H. (2013). An evaluation of marginal fit of three-unit fixed dental prostheses fabricated by direct metal laser sintering system. Dental materials, 29(7), e91-e96.
13. Duret, F. J. C. P. (1985). Toward a new symbolism in the fabrication of prosthetic design. Cah Prothese, 13, 65-71.
14. Gjelvold, B., Chrcanovic, B. R., Korduner, E. K., Collin-Bagewitz, I., & Kisch, J. (2016). Intraoral digital impression technique compared to conventional impression technique. A randomized clinical trial. Journal of Prosthodontics, 25(4), 282-287.
15. Kokubo, Y., Ohkubo, C., Tsumita, M., Miyashita, A., Vult von Steyern, P., & Fukushima, S. (2005). Clinical marginal and internal gaps of Procera AllCeram crowns. Journal of oral rehabilitation, 32(7), 526-530.
16. Wöstmann, B., Rehmann, P., Trost, D., & Balkenhol, M. (2008). Effect of different retraction and impression techniques on the marginal fit of crowns. Journal of dentistry, 36(7), 508-512.
17. Beuer, F., Aggstaller, H., Edelhoff, D., Gernet, W., & Sorensen, J. (2009). Marginal and internal fits of fixed dental prostheses zirconia retainers. Dental Materials, 25(1), 94-102.
18. Harris, I. R., & Wickens, J. L. (1994). A comparison of the fit of spark-eroded titanium copings and cast gold alloy copings. International Journal of Prosthodontics, 7(4).
19. Syrek, A., Reich, G., Ranftl, D., Klein, C., Cerny, B., & Brodesser, J. (2010). Clinical evaluation of all-ceramic crowns fabricated from intraoral digital impressions based on the principle of active wavefront sampling. Journal of dentistry, 38(7), 553-559.
20. Almeida e Silva, J. S., Erdelt, K., Edelhoff, D., Araújo, É., Stimmelmayr, M., Vieira, L. C. C., & Güth, J. F. (2014). Marginal and internal fit of four-unit zirconia fixed dental prostheses based on digital and conventional impression techniques. Clinical oral investigations, 18, 515-523.