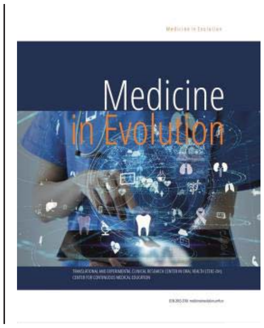
Luting space assessment of metal free fixed partial prostheses. A qualitative study.



Pop D.M., Sinescu C., Craciunescu E.L., Cojocariu A.C., Gabor A.G., Negrutiu M.L., Rominu M.

Department of Prostheses Technology and Dental Materials, Faculty of Dental Medicine,"Victor Babeș"University of Medicine and Pharmacy Timișoara, no. 9 Revoluției 1989 Ave., 300070 Timişoara, Romania
Research Center in Dental Medicine Using Conventional and Alternative Technologies

Correspondence to:
Name: Craciunescu Emanuela Lidia
Address: p-ta Eftimie Murgu nr.2, Timisoara, Romania
Phone: +40 744616009
E-mail address: emanuela.craciunescu@umft.ro

Abstract

The aim of this *ex vivo* study is to assess with digital microscopy the thickness of luting space of metal free FPP made with technologies: selective laser sintering, milling and pressing.

Twelve metal free FPP were designed after two technological protocols. The first group was made with pressed ceramic (IPS E.max Ceram). The veneering was made with feldspalthic ceramic IPS (E.max Ceram). The second group of samples was made with CAD/CAM subtractive technology. The metal free infrastructures were digitally designed for milling in zirconium oxide discs (IPS E.max ZirCAD). The prostheses adaptation was measured and checked with dedicated silicone.

The evaluation of internal adaptation with optical microscope is more accurate.

The silicone has a resilient characteristic and may influence the results. The measurement made with digital microscope are accurately higher.

Keywords: full ceramic, luting, optical microscopy

INTRODUCTION

The aesthetical standards are rising along with metal free fix partial prostheses. The evaluation on long-term success, consider the following criteria: the quality of marginal adaptation, fracture resistance, aesthetic appearance and response of pulp and marginal periodontium [1]. Subtractive alternative technologies, CAD-CAM, has a high success rate of fix partial prostheses longevity [2]. Internal and external marginal adaptation is important for indirect restauration along with the space for cement. Recent studies demonstrated that a 100-200µm cement thickness is clinically acceptable for a good prognostic on long term [3].

Evaluation of metal free restorations consider two important factors: mechanical resistance and marginal adaptation [4]. Evaluation of external and internal marginal adaptation of metal free prostheses is essential for mechanical resistance and prevention of abutments cervical carries. CAD-CAM technology for full ceramic prostheses is using a milling process and volume reduction of ceramic blocks until the finally designed shape.

The additive technology is used for fast prototyping when it is necessary to obtain highly individualized prostheses [5, 6]. The specifications of these technologies relies on the use of varied thermos-plastic powder, which will tolerate high geometric precision [7]. At this phase, possible encountered mistakes become evident and are usually irreparable [5].

The inner surface off metal free prostheses needs a chemically or micro-mechanically conditioning to improve the luting cement. The best surface conditioning for zirconium is sandblasting with Al_2O_3 prior luting. Etching and silan conditioning are not efficient on zirconium because it is an inert material without a sensitive matrix for acids and silans. Long-term clinical studies are necessary to evaluate and confirm the stability of cements and zirconium interface [8].

Zirconium has a polycrystalline microstructure with high fracture and acid resistance; for this reason, the adhesion of resin cements is weak. Adhesive cements have a different composition and the lack of information about their properties and their interaction with the zirconium can lead to long term compromises [9]. The design of the abutment must accomplish specific conditions to support the retention and stability of prosthetic restauration. Crowns retention depends by abutments geometric shape, inner crowns roughness, restorative materials, type and thickness of luting cement [5]. The acceptable values for film cement thickens are between 25-200 µm. The application of a spacer on the cast assure the space for cement film. [5].

The modern optic microscope can magnify up to 1500 x with a limit of 0.2µm in spatial resolution and is engaged in the evaluation of luting space. Optical microscope with lighted field cannot change the lightening phase and transparent specimens become invisible when are investigated [11, 12]. The measurement of luting space has to be the best specially at the marginal limit of the preparation. If the technological processing is correctly done, no remarkable differences are detected in the oral cavity [13].

MATERIAL AND METHODS

For this study were made two 12 full ceramic prostheses. For the first group were made 6 prostheses after the following protocol: wax patter, investment, and ceramic pressing (IPS E.max Ceram, Ivoclar Vivadent, Schaan, Lichtenstein). Rods of 3.0mm diameter and length of 3-8mm are attach to the wax pattern followed by investment with Just Pressables and Vest Liquid (Ivoclar Vivadent). The setting time of investment material lasts 45 minutes, the assembly is placed in the oven Programmat EP300 (Ivoclar Vivadent). It is chose the colour of the ceramic ingot and placed in the piston (IPS Alox Plunger, Ivoclar Vivadent,). For individual morphology, the pressed ceramic is veneered with (IPS E.max Ceram, Ivoclar Vivadent). Samples of the second group are make with the subtractive technology: the infrastructure was made from zirconia with CAD-CAM system using Exocad program and the individualization was made with sintered ceramic. The design of the wax patterns and milled infrastructure was made digitally in zirconium oxide shaded discs IPS E.max ZirCAD, (Ivoclar Vivadent) milled for 25 minutes. The copings are removed and the rods are cut and finished. The samples were placed on the working casts along with Fit Checker Advanced Blue (GC, Japan). Advantages of Fit Checker silicone are: low viscosity under pressure, minimal film thickness for a precise fit of the restauration on the abutment and transparent blue colour that allows the occlusal evaluation even at a thickness film below 100µm [15].

Two measurements were made for all the samples. First the Fit Checker silicone was layed on the inner surface of the retainer and placed on the abutment. (Fig.1). After the setting of the silicone the retainer was removed. The silicone material remained in the retainer and after setting three measurements were made with Ritter Dent micro-meter in pre-established areas, marked on the buccal, oral, and incisal/occlusal surface of the retainers For each samples were made six measurements; 3 with the Fit Checker and 3 without Fit Checker. The space reserved to the cement film was calculated (Fig.2). After the setting, the silicone is gently removed from the retainer and measured in the same agreed points of the first measurement technique. (Fig.3)

Figure 1. Layering of silicone on the inner surface of the samples of group 2

Figure 2. Sample 3, measurements of occlusal thickness with and without Fit Checker silicone

Figure 3. Direct buccal measurement of silicone thickness, sample 1, group2

The third measurement was made with digital microscope. The 12 samples were placed on a wax for stability and measured with the microscope's software.

RESULTS

Measurements were made for all twelve samples using the two different techniques with the micro-meter and optical microscope. The measurements made with the digital microscope were mainly in the cervical area (Fig. 4, 5, 6).

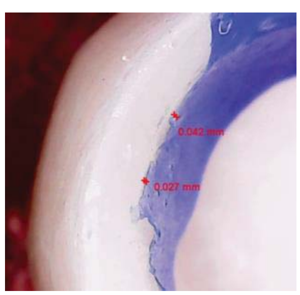


Figure 4. Digital measurement of the silicone thickness on the buccal face, sample 5, group 2

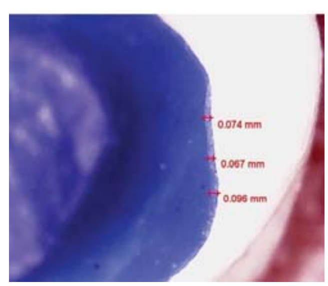


Figure 5. Digital measurement of the silicone thickness on the oral face, sample 7, group 1

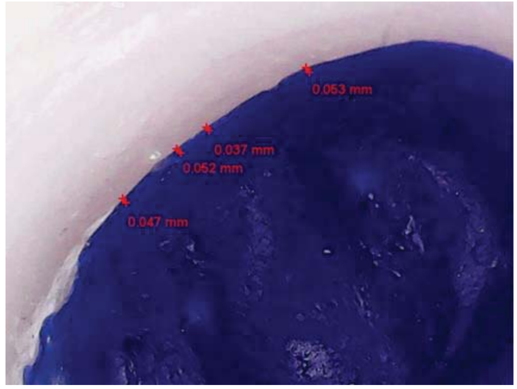


Figure 6. Digital measurement of the silicone thickness on the oral face, sample 10, group 1. Silicone thickness- 0.047mm, 0.052mm, 0.037mm, 0.053 mm

The measurements with the first technique (3 with the Fit Checker and 3 without Fit Checker) the difference between the measured values with silicone and without silicon registered the higher values for group 2 samples 8, 9, 11; the average value was 166,6 µm, meaning a higher clinical resistance to fracture and fissures. The lowest value 83,3µm was registered for sample 5 of group 1 meaning a higher risk for fracture.

Table 1. The measurements made using the thickness difference (3 with the Fit Checker and 3 without Fit Checker)

Sample	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	
Buccal µm	100	100	100	50	100	150	150	200	200	150	200	200	
Oral µm	150	100	150	100	50	100	100	200	200	150	150	150	
Occlusal µm	150	100	100	150	100	150	100	100	100	150	150	150	
Avarage Ø -µm-	133	100	116,6	100	83,3	133	116,6	166,6	166,6	150	166,6	166,6	ØTOTAl 130,2

The second protocol measured directly the thickness of the silicone. The highest thickness registered for the second protocol were registered by group 2 samples 8 and 9. The average value is 133,3µm and is considered to be optimal for a good mechanical resistance. The minimal value of the second measurement protocol was registered for group 1 sample no 4 and 5. The average value was 50µm, which represents a higher risk for fracture. The total average (Tab.2) of measured thicknesses of each sample is lower for the second measurement protocol with an average difference of 40,8µm. The second measurement protocol delivered lower or equal results with the ones delivered by the first measurement protocol. All the measurements were made in the same points of the retainer.

Table 2. Direct measurements of the silicone layer

Sample	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	
Avarage Ø -µm-	83,3	66,6	83,3	50	50	83,3	100	133,3	133,3	83,3	116,6	100	ØTOTAL 89,4

The total average for all the measurements is 130,2 µm for the first measurement protocol and 89,4 µm for the second protocol and 63,06µm for the optical microscopy.

Table 3. Direct measurements of the silicone thickness made with oprical microscope

Sample	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	
Buccal µm	96	101	86	89	82	94	91	103	98	92	99	98	

Oral µm	42	35	40	46	33	38	44	48	45	36	49	45	
Occlusal µm	53	60	57	49	45	47	54	60	55	56	58	55	
Avarage Ø -µm-	63,66	65,33	61	61,33	53,33	59,66	63	70,33	66	61.33	68,66	66	ØTOTAL 63.06

The lowest values registered with the optical microscope belongs to group 1 sample no. 5- higher risk for fracture. The highest value was registered for group 2 sample no 8- high fracture resistance.

DISCUSSIONS

Non-invasive evaluation of marginal and internal fir of zirconia crowns register values between 50µm up to 170µm. These values are clinically acceptable and with a good prognostic on long term [3].

Research studies related to cement thickness film demonstrates that the film thickness ca vary between 10µm up to 152µm, depending by the luting material [16].According to ISO Standards the cement thickness for full ceramic restorations has to be equal or smaller than 50µm for resin cements [17].

Another study investigated different types of luting cements, and more exactly the effects of film thickness over stress distribution for full ceramic restorations and an optimal thickness is approximately 90µm. The size of this film thickness can reduce the stress present at the cement film and restorative material interface [18].

In case of composite resin cements and adhesive resin cements, the film thickness can be higher than 25µm because in these materials have low solubility and are elective for full ceramic restauration [14].

CONCLUSIONS

The evaluation of internal fit of full ceramic restorations, made with optical microscopy is a more accurate technique because of the digital factor of this technology. The measurements are more précises and avoid the possible errors related to silicon's resilience.

Though the check with the silicone is optimal for clinical check, it's resilience may significantly influence the *in vitro* results.

The first two measurement techniques registered higher values than the measurements made with the optical microscope and makes them less accurate.

The most accurate and error free measurement was made with the optical microscope.

REFERENCES

1. Stappert CFJ, Dai M, Chitmongkolsuk S, Gerds T, Strub JR: Marginal adaptation of three-unit fixed partial dentures constructed from pressed ceramic systems. Br Dent J. 2004 Jun26;196(12):766-70
2. Borba M, Cesar PF, Griggs, AJ, Della Bona A: Adaptation of all-ceramic fixed partial dentures. Dent Mater. 2011 Nov; 27(11): 1119–1126
3. Cunali RS, Saab RC, Correr GM, Fernandes da Cunha L, Ornaghi BP, Ritter AV, Gonzaga CC: Marginal and Internal Adaptation of Zirconia Crowns: A Comparative Study of Assessment Methods, Braz Dent J. Jul-Aug 2017;28(4):467-473
4. Ural C, Burgaz Y, Sarac D: In vitro evaluation of marginal adaptation in five ceramic restoration fabricating techniques, Quintessence international. July 2010, 41(7):585-90
5. Bratu D, Nussbaum R: Bazele clinice şi tehnice ale protezării fixe. Ed. Signata, Timişoara. 2001, isbn: 978-973-39-0580-6

6. Meirowitz A, Bitterman Y, Levy S, Mijiritsky E, Dolev E: An in vitro evaluation of marginal fit zirconia crowns fabricated by a CAD-CAM dental laboratory and a milling cente, BMC Oral Health. 2019 volume 19, 103
7. Barazanchi A, Li KC, Al-Amleh B, Lyons K, Waddell JN: Additive Technology: Update on Current Materials and Applications in Dentistry. J Prosthodont. 2017 Feb;26(2):156-163.
8. A. Sinescu C, Negruțiu ML, Romînu M, Leretter M: Alternative tehnologice în medicina dentară, Editura Mirton. 2006, 187 pg., ISBN: [10] 973-52-0052-X; [13] 978-973-52-0052-7
9. Gargari M, Gloria F, Napoli E, Pujia AM: Zirconia: cementation of prosthetic restorations. Literature review. Oral Implantol (Rome). 2010 Oct-Dec; 3(4): 25–29
10. Petre A, Sfeatcu R: Adhesive cementation protocol of Zirconia restorations. Journal of Oral Rehabilitation. 2011, Vol.3 (no.3):84
11. Bhowmik H, Parkhedkar R: A comparison of marginal fit of glass infiltrated alumina copings fabricated using two different techniques and the effect of firing cycles over them. J Adv Prosthodont. 2011 Dec; 3(4):196-203
12. Măroiu AC, Sinescu C, Duma VF, Topală F, Jivănescu A, Popovici PM, Tudor A Romînu M: Micro-CT and Microscopy Study of Internal and Marginal Gap to Tooth Surface of Crenelated versus Conventional Dental Indirect Veneers, Medicina 2021, 57(8), 772
13. Chen X, Zheng B, Liuc H: Optical and digital microscopic imaging techniques and applications in pathology, Anal Cell Pathol (Amst). 2011; 34(1-2): 5–18.
14. Rosenstiel FS, Lan MF: Contemporary fixed prosthodontics, 5th Edition, 2016
15. Lee JH, Son K, Bok Lee K: Marginal and Internal Fit of Ceramic Restorations Fabricated Using Digital Scanning and Conventional Impressions: A Clinical Study. J. Clin. Med. 2020, 9(12), 4035;
16. De la Macorra JC, Pradíes G: Conventional and adhesive luting cements, Clin Oral Investig 2002 Dec;6(4):198-204
17. Habib SR, Ansari AS, Bajunaid SO, Alshahrani A, Javed MQ: Evaluation of Film Thickness of Crown Disclosing Agents and Their Comparison with Cement Film Thickness after Final Cementation, Eur J Dent 2020 Mar;14(2):224-232
18. Liu B, Wu Y, Zhang D: The effects of Adhesive Type and Thickness on Stress Distribution in Molars Restored with All-Ceramic Crowns. Journal of Prosthodontics, January 2011, 20(1):35 – 44.