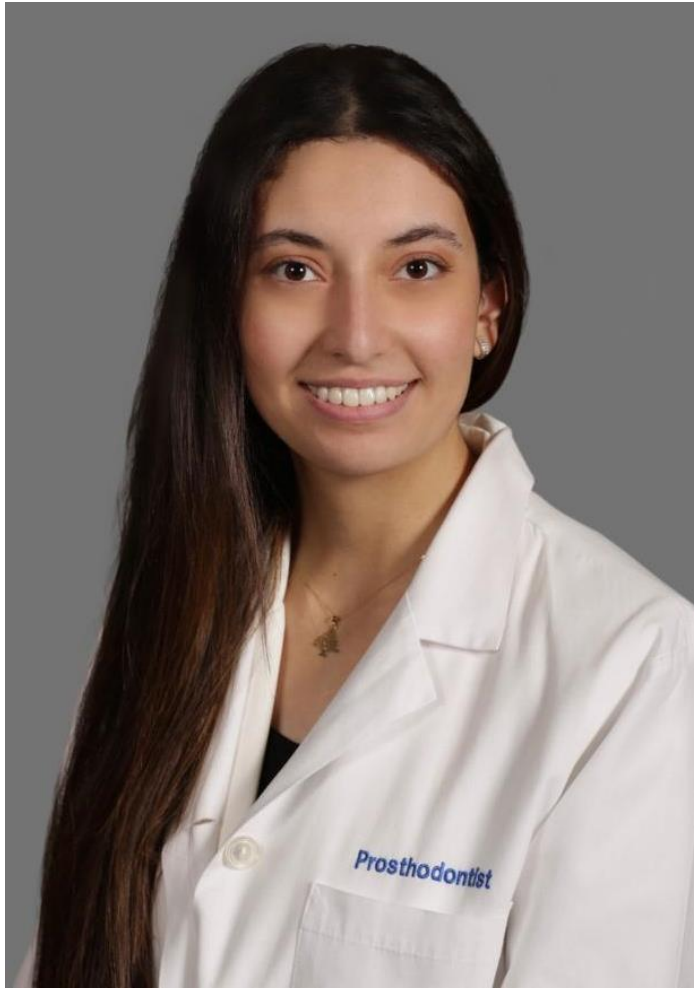




Marginal fit comparison between 3D printed ceramic-filled resin and CAD/CAM milled Zirconia for maxillary anterior single crowns

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Objectives

This study aims to examine the marginal gap at the mid-facial, mid-lingual, mid-mesial, and mid-distal locations of the prepared tooth for both milled and printed crowns.

Hypothesis

We hypothesize that CAD/CAM milled Zirconia maxillary crowns will have a better marginal fit at all dimensions when compared to those 3D printed.

Introduction

PFM restorations are the gold standard for their mechanical properties,¹ but face certain limitations.^{2 3} Ceramics, especially zirconia, have become popular in dentistry for their esthetics, biocompatibility, and superior mechanical properties.⁴

In 2023, SprintRay introduced "Ceramic Crowns," made of over 50% ceramic, offering high strength and wear resistance. Available in multiple shades, these crowns are FDA cleared and CDT compliant.

A precise marginal fit is essential for crown longevity, as discrepancies can lead to plaque buildup, inflammation, caries, and bone loss.^{5 6 7}

Materials and Methods

In this study a total of 52 maxillary anterior single crowns were fabricated. 26 crowns were milled from Ivoclar e.max ZirCAD using the Roland DWX-52DCI milling machine and 26 crowns were 3D printed from a ceramic-filled resin material using the SprintRay Pro 55s printer.

Each crown was designed with a shoulder margin, incorporating a 1.5 mm buccal reduction, 1 mm mesial, distal, and lingual reduction, and a 1.5 mm incisal reduction to ensure accurate fit on a pre-prepared abutment tooth (#8), which was obtained from Columbia Dentoform.

The marginal gap was assessed at four locations: mid-facial, mid-lingual, mid-mesial, and mid-distal on the prepared tooth using a Zeiss optical microscope at 20x magnification. A two-sample t-test was employed to compare the marginal gaps between the milled and 3D-printed crowns at each of the four measured locations.



Fig.1- Pre-prepared abutment #8

Fig.2- 3shape desktop scanner (E4)

Fig.3- Designed crown using 3shape software

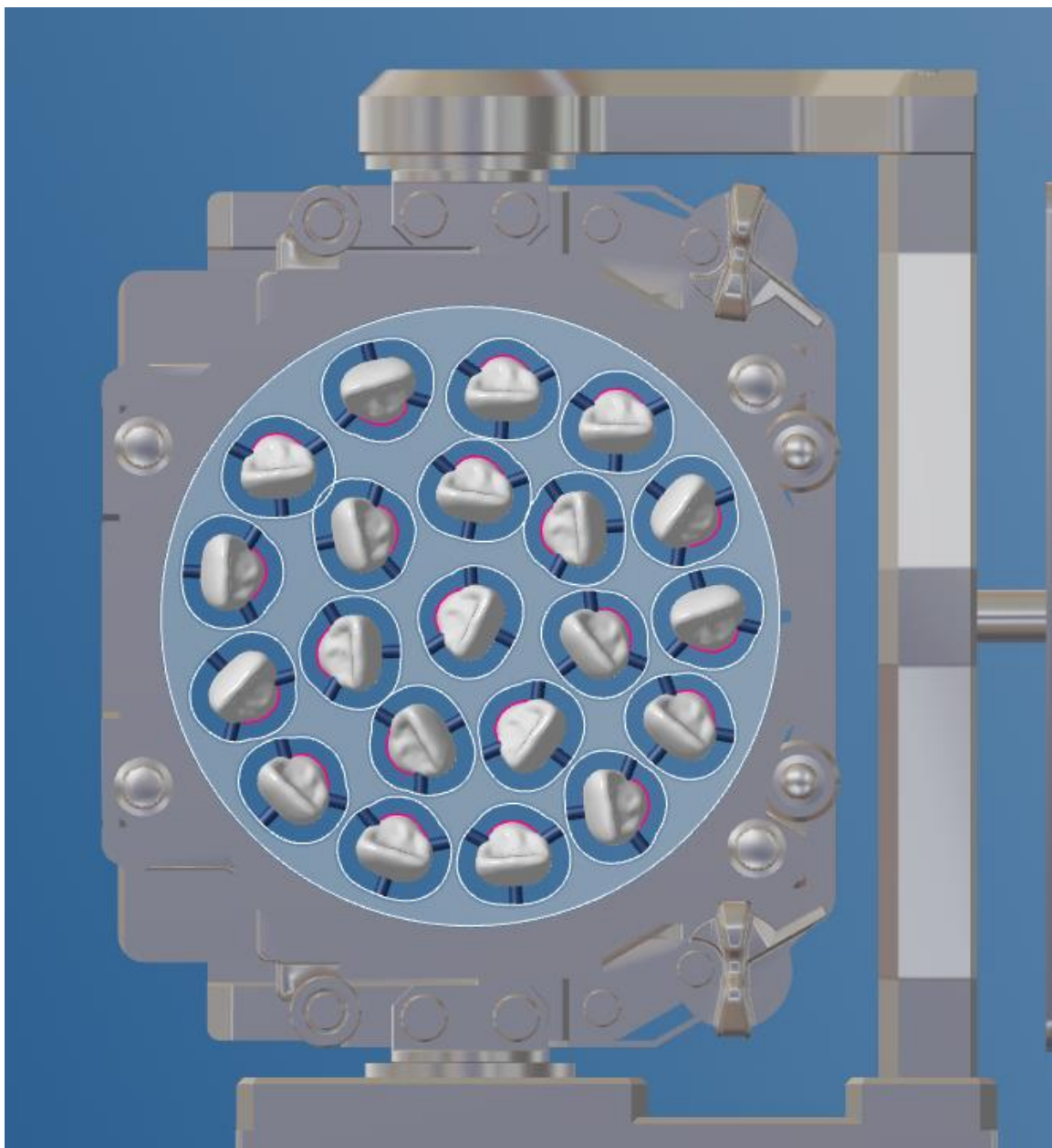


Fig.4,5,6- Milled crowns and their production workflow

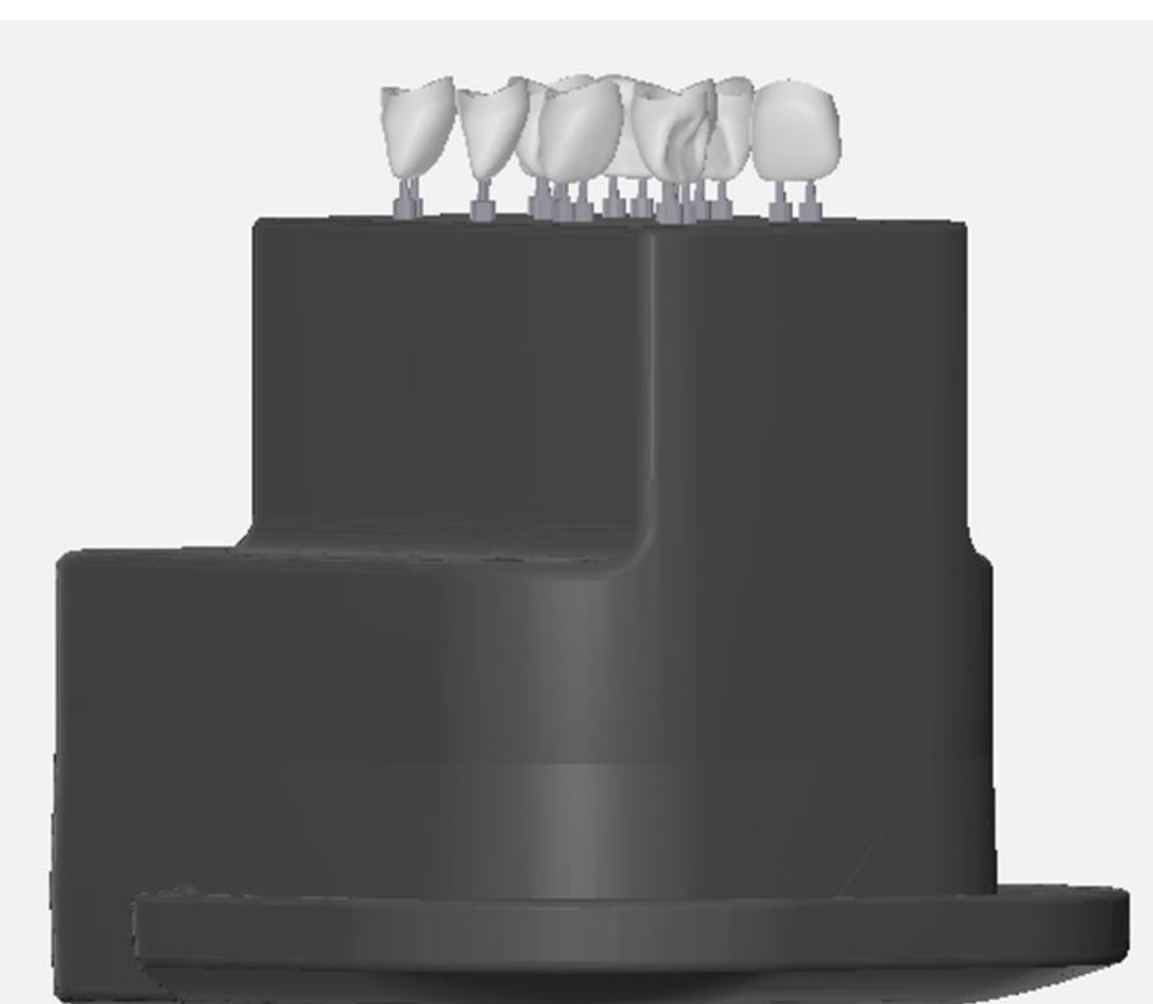


Fig.7,8,9- Printed crowns and their production workflow



Fig.10- Zeiss Optical Microscope x20 magnification

Results

The mean and standard deviation of the marginal gaps were lower at all measured locations for the milled zirconia crowns milled using the Roland DWX-52DCI milling machine compared to the printed ceramic crowns printed by the SprintRay Pro 55s printer ($p < 0.05$). Additionally, the marginal gaps for all locations on the printed crowns exceeded the clinically acceptable threshold of 50µm.

Milled Crowns

	Facial	Lingual	Mesial	Distal
Crown M1	24.65	23.05	19.59	9.93
Crown M2	19.02	12.54	18.55	11.81
Crown M3	16.38	8.25	15.43	19.97
Crown M4	11.77	12.83	14.90	15.90
Crown M5	10.79	18.45	4.37	12.38
Crown M6	13.92	17.16	17.88	20.02
Crown M7	24.96	7.69	12.32	15.39
Crown M8	19.11	6.33	28.16	19.18
Crown M9	4.63	10.28	20.02	16.26
Crown M10	9.77	9.84	21.14	18.94
Crown M11	12.32	6.86	15.87	14.41
Crown M12	14.33	6.33	25.95	17.47
Crown M13	19.97	26.10	19.59	21.98
Crown M14	17.03	12.79	12.28	9.72
Crown M15	16.57	11.44	12.39	9.21
Crown M16	13.85	8.25	11.78	8.76
Crown M17	9.61	15.43	13.63	16.48
Crown M18	6.18	8.09	9.88	9.43
Crown M19	8.20	9.56	12.64	6.73
Crown M20	10.44	10.85	11.36	11.77
Crown M21	7.18	4.37	9.43	15.87
Crown M22	10.75	7.23	17.41	4.09
Crown M23	15.94	9.52	7.32	10.94
Crown M24	13.92	7.94	14.05	6.67
Crown M25	12.04	16.88	9.84	9.21
Crown M26	11.50	7.23	8.27	10.94

Printed Crowns

	Facial	Lingual	Mesial	Distal
Crown P1	226.28	286.68	131.47	106.02
Crown P2	185.74	56.98	177.06	105.00
Crown P3	356.03	102.66	116.38	273.96
Crown P4	318.80	214.39	107.36	183.67
Crown P5	561.32	58.88	166.96	316.87
Crown P6	44.54	27.43	40.52	39.86
Crown P7	97.59	14.36	34.82	59.43
Crown P8	232.75	34.43	147.52	193.51
Crown P9	519.19	474.77	135.28	419.26
Crown P10	103.12	28.78	52.68	82.94
Crown P11	383.16	235.54	234.05	316.36
Crown P12	94.18	19.45	13.90	17.52
Crown P13	407.19	91.77	13.60	191.99
Crown P14	486.92	156.08	46.94	248.33
Crown P15	476.75	107.76	243.48	180.85
Crown P16	463.75	77.97	44.37	208.96
Crown P17	401.43	200.91	167.75	296.91
Crown P18	289.86	308.16	116.19	35.55
Crown P19	90.22	48.19	27.43	32.25
Crown P20	95.00	22.99	17.76	54.83
Crown P21	496.43	318.36	266.82	306.30
Crown P22	597.58	273.20	199.68	535.51
Crown P23	293.51	92.79	77.73	232.40
Crown P24	544.57	271.74	161.15	496.01
Crown P25	408.13	316.36	105.97	514.31
Crown P26	129.03	23.03	33.47	122.38



Fig.11- fit of milled crown under microscope

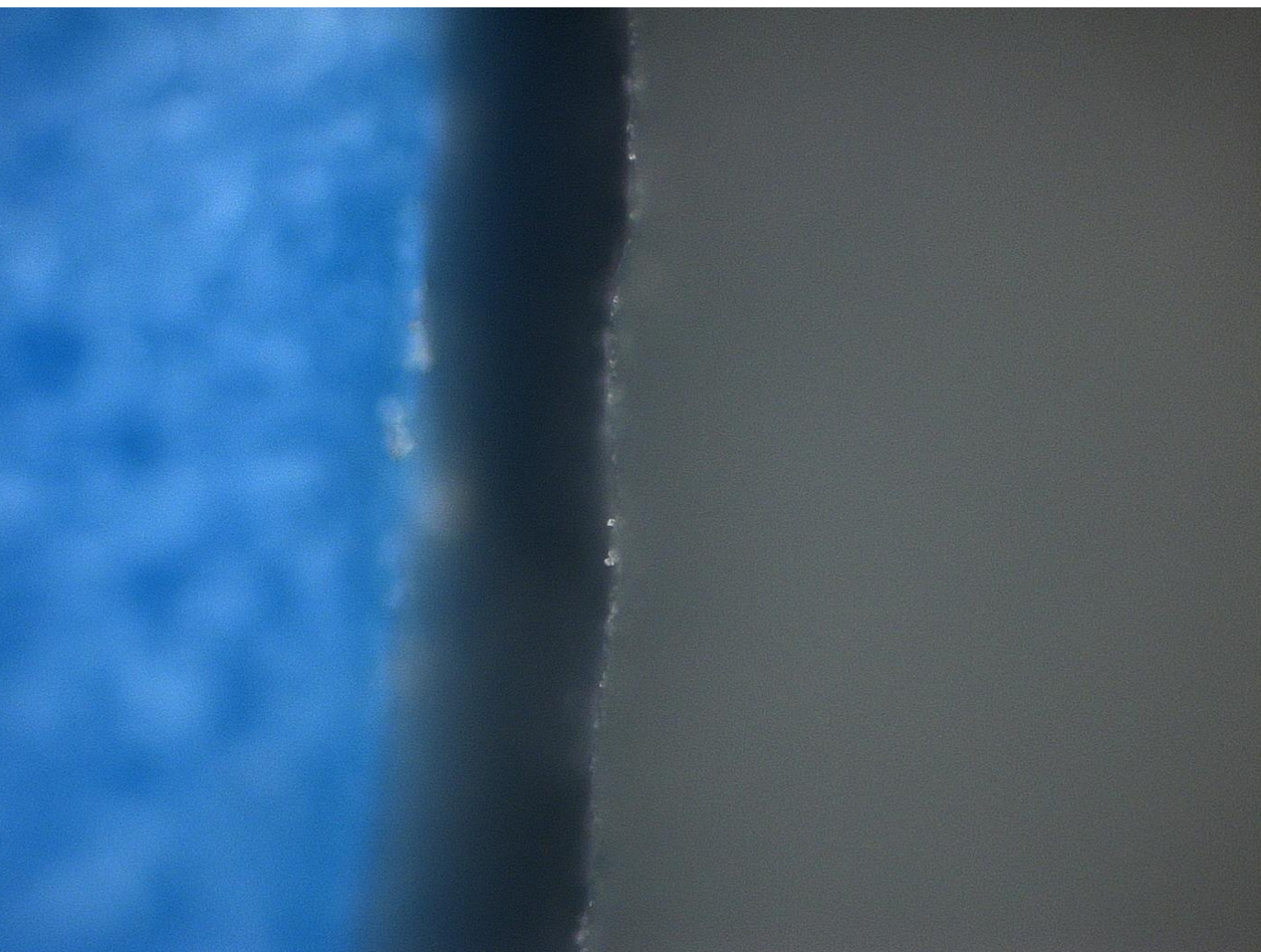


Fig.12- fit of printed crown under microscope

Conclusion

Printed ceramic crowns are not an acceptable alternative to milled zirconia crowns, as the marginal gaps in all measured locations for the milled crowns were within the clinically acceptable range of 50µm.

References:

