Keywords

Ceramic, resin nanoceramic, lithium disilicate, CAD-CAM, occlusal thickness, accuracy, fit, gap, marginal, internal

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Evaluation of marginal and internal fit of posterior monolithic resin nanoceramic crowns

ABSTRACT

Purpose: To assess the fit accuracy of resin nanoceramic (RNC) crowns in comparison with lithium disilicate (LDS) crowns, in terms of marginal and internal gap, and to investigate the effect of crown occlusal thickness (OT) on the fit, for both materials.

Materials and Methods: Forty stone dies were derived from a master metal die, with 20 each for the 0.5mm and 0.75mm minimum OT groups. The stone dies were digitized to design and mill the ceramic crowns, 10 each for the 4 material–OT combinations (n=10). All the crowns were seated on the master metal die using silicone fit checker. The silicone records were then fixed and sectioned. Marginal gaps were assessed at 6 locations, and internal gaps were measured at 48 points, on the silicone record sections, for each crown, using a stereomicroscope-based image analysis system. The effects of the material and occlusal thickness on the crown fit were analyzed with 2-way ANOVA and Bonferroni post-hoc tests (α=.05).

Results: Mean marginal and internal gaps for RNC crowns were 73±16µm and 157±7µm, and 84±19µm and 155±12µm for the LDS crowns, respectively. Two-way ANOVA showed significant marginal gap differences between the 2 materials, and between the OTs (P<.05). However, internal gap differences were not significant (P>.05), although internal gaps differed significantly according to occlusal thickness (P<.01).

Conclusions: The marginal and internal gaps of RNC and LDS crowns were found to be within acceptable limits. Occlusal thickness significantly affected the internal gap of both materials.

INTRODUCTION

Resin nanoceramics (RNC) are currently used in the computer-aided design and computer-aided-manufacturing (CAD-CAM) production of fixed dental prostheses, including crowns.[1-3] RNCs are hybrid materials available as monolithic machinable ceramic blocks, composed of nano particles (silica, zirconia and/or barium) in a composite resin matrix.[4,5] The RNCs are purported to have better mechanical properties compared with the conventional glass ceramics, including less abrasiveness, high flexural strength, and intra-oral reparability, in addition to superior marginal integrity, no sintering or firing requirement, and ease of polish.[5-8]

Marginal fidelity is a vital criterion used to ascertain the clinical acceptability of indirect restorations at placement and at follow-up examinations.[9,10] Excessive marginal discrepancies may potentially lead to periodontal disease, cement dissolution, recurrent caries, and even pulpal inflammation.[11-15] Different factors, including the type of ceramic,[16,17] cement space setting,[18] abutment preparation design,[19] and CAD-CAM milling system parameters,[20,21] have been shown to influence the borderline and core fit aspects of fixed restorations. Furthermore, inadequate internal adaptation and luting cement thickness may affect the fracture resistance of ceramic crowns.[20,22] Previous systematic reviews[22,23] and related guidelines[24] have suggested 80-120 µm as a clinically appropriate range of borderline gaps for ceramic CAD/CAM

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complete coverage crowns.

Recent studies have analysed the fit ~~correctness~~ accuracy of RNC restorations (crowns, onlays, inlays, endocrowns, and veneers),[1,2,17,20,21,26-30] yet data is scarce on the ~~borderline~~ marginal and internal fit of posterior RNC crowns. The current available studies explored the molar RNC crown fit,[26,28-30] but investigations on premolar crown fit are unavailable in scientific literature. The distinction may be clinically relevant to warrant examination, as molars present a broader occlusal surface and more complex anatomical contours compared to premolars, which may influence both the scanning accuracy and milling precision during the CAD-CAM workflow.

To the authors' knowledge, all existing studies[26,28-30] evaluating the marginal and internal fit of RNC crowns had employed 4-axis milling machines for the fabrication. Recent systematic reviews[20,21] indicated that 5-axis milling machines delivered superior fitting ceramic restorations compared with the 3-axis and 4-axis systems, although the reported restoration types were inlays, onlays, and porcelain laminate veneers. There is a lack of evidence on the use of 5-axis milling units for the assessment of RNC crown marginal fit.

The effect of occlusal thickness (OT) on the fit accuracy of molar RNC crowns has been investigated revealing significant marginal gap differences between crowns of 0.8 mm and 1 mm thickness.[26] However, this study[26] did not assess the internal fit of crowns. The authors are unaware of any other report in scientific literature analysing the occlusal thickness effect on the fit accuracy of RNC monolithic crowns, specifically with 0.5 mm and 0.75 mm minimal occlusal thicknesses.

The purpose of this in vitro study was to ascertain and compare the accuracy of fit of premolar crowns made of lithium disilicate and monolithic resin nanoceramic at two distinct occlusal thicknesses, 0.5–1 mm and 0.75–1.25 mm, in terms of the marginal and internal gap between the crowns and the master metal die. The RNC and LDS crowns, as well as crowns with varying occlusal thicknesses (0.5–1 mm and 0.75–1.25 mm), would all have the same marginal and internal gap values, according to the null hypothesis.

MATERIALS & METHODS

Fabrication of crown samples

A cast cobalt–chromium (Co-Cr) metal die (Figure 1) was duplicated from a maxillary second premolar ivorine tooth preparation with the following features: 1 mm wide rounded shoulder finish line, < 20º axial wall taper, and 4 mm axial wall height, according to earlier studies.[7,31,32] The master die was partially inserted and stabilized in a readymade brass cylinder with acrylic pattern resin.[7,16]

The sample size for this study was determined based on previous similar investigations.[28,29] For an assumed mean marginal gap difference of 64 μm and standard deviation of 34 μm,[29] at $\alpha = 0.05$ and observed power of 0.90 (G*Power v.3.1.9.7; Heinrich Heine University Düsseldorf, Germany), a required sample size of 8 crown specimens was calculated for each crown material-OT test group, in order to estimate whether there was a significant difference in the marginal gap. The number was rounded off to 10 samples per group, for the marginal and internal gap evaluation.

Forty impressions (light body and regular body polyvinyl siloxane; 3M ESPE, Express XT, Neuss, Germany) of the master die were made with custom trays and poured in type IV dental stone. After assessment under the microscope (10X), the 40 stone dies were randomly assigned to one of the 2 crown groups, 20 RNC (Lava Ultimate; 3M ESPE AG, Seefeld, Germany) and 20 LDS (e.max CAD, Ivoclar Vivadent AG, Bad Säckingen, Germany). The 2 crown material groups were further divided into sub-groups of 10 each, based on the crown minimum occlusal thickness of either 0.5 mm or 0.75 mm (n=10).

The stone dies were digitally scanned (Medit T710; Medit Corp., Seoul, Republic of Korea) and the virtual dies were randomly assigned for designing crowns (Dental CAD 3.0; Exocad GmbH, Darmstadt, Germany) of the different material-OT groups, following no specific sequence. The crown design procedures were completed in 3 days, over multiple sessions, with each session generating at least 4 digital samples. A consistent occlusal design was maintained for the maxillary 2nd premolar with mean occlusal thickness of 0.5 mm in the central groove region reaching a maximum of 1 mm at the cusp tip, and with 0.75 mm at the central groove with maximum of 1.25 mm at the cusp, with 50 μm cement space, for both RNC and LDS groups (n = 10). LDS (IPS E.max CAD) and RNC blocks (Lava Ultimate) were then used for milling the crowns with a 5-axis milling machine (CEREC InLab MC X5, Dentsply Sirona Inc., Charlotte, NC, USA). Recommended milling and grinding tools were used for machining, replacing new bits for every crown material-OT group (n=10).

The LDS crowns were fired at 850 °C (25 min) in a ceramic furnace, for the crystallization procedure.[31,33] All the crowns (LDS and RNC) were washed and cleaned in an ultrasonic cleaner before finishing and polishing, on the respective stone dies, under the microscope (10X).[7,16,31] All procedures related to the crowns were completed by a single experienced dental technician, in a commercial lab. Forty crowns were thus fabricated for marginal and internal fit evaluation (10 RNC-OT 0.5 mm, 10 RNC-OT 0.75 mm, 10 LDS-OT 0.5 mm, 10 LDS-OT 0.75 mm).

Measurement of marginal and internal fit

A silicone replica technique was employed to aid in the measurement of marginal and internal fit of crowns, based on previous studies.[31,34,35] Each fabricated crown was injected with low-viscosity silicone (GC VPES Fit checker advanced, GC Corp, Tokyo, Japan) on its fitting surface and seated on the master metal die under finger pressure and held until the silicone material set. The crown was then removed from the metal die and the thin layer of silicone film adhered on the intaglio surface was stabilized with heavy-body silicone (Aquasil Ultra Rigid Regular Set, Dentsply Detrey GmbH), to enable easy handling and preparation of silicone record cross-sections, for the determination of marginal and internal gaps of the crowns, in relation to the abutment tooth. The silicone replica molds were created for all the crowns of the 4 test groups, by repeating the above-mentioned process, in no particular order (n=40), by a single operator, over several sessions. The resultant silicone replica records for the 40 crowns were sectioned (surgical scalpel blade no. 15) and divided into six parts for each crown—buccal, mesio-buccal, mesio-lingual, lingual, disto-lingual and disto-buccal, as elicited in Figure 2.[31]

The marginal and internal fit evaluation of the crowns were then performed on the silicone cut sections using a computerized digital image analysis system, consisting of a stereomicroscope (SZX7-ILST-SET Stereo Microscope; Olympus Corp, Tokyo, Japan), CCD [charge-coupled device] camera (X-cam, The Imaging Source Asia Co Ltd, Taiwan, PRC), image capture and processing software (Cell D Image Analysis Software Ver. 3.1, Olympus Corp, Tokyo, Japan) installed on a desktop computer, attached to a computer monitor screen.[18,32,33] Before proceeding with the evaluation of crown marginal and internal fit, the measurement set up was calibrated and verified for reliability and accuracy, according to previous studies.[31,33] Based on the results, the system was found to be accurate to ±4 µm.

Each silicone cut section was individually examined under the stereomicroscope (x15 magnification) and photographs were taken using the CCD camera. The acquired images were processed using image analysis software and assessed on the computer monitor screen. Once found satisfactory, the images were ~~established~~ confirmed and saved on the computer for marginal and internal gap valuation.

The marginal and internal gap measurements were made by the same investigator, at 6 marginal and 48 axial-occlusal wall locations, for each crown, based on the scheme used in earlier studies.[31,32,36] One marginal and 8 internal gaps (4 on axial wall and 4 on the occlusal wall) were measured on each silicone cut section. The points on the axial and occlusal walls were chosen to be approximately intermediate to each other, as shown in the representative image (Figure 3). All observations and measurements were conducted following previous similar studies.[31,33] *Marginal gap* was defined as the perpendicular gap between crown margin to the abutment finish line, as described by Holmes et al.[31,33,37] *Internal gap* was defined as the perpendicular distance between the axial or occlusal surface to the intaglio surface of the crown.[31] An average of 3 readings recorded at every marginal and internal location site was used as the value for the specific location. Intra-operator reliability assessment was conducted and revealed high intra-class correlation coefficients of 0.96 and 0.92, for marginal and internal gap, independently ($\alpha = 0.05$). A 2nd operator conducted the fit measurements on randomly chosen samples in each test group, to examine the correctness of data. An acceptable inter-operator reliability was achieved through inter-class correlation coefficients of 0.92 for marginal gap and 0.90 for internal gap, at 95% confidence interval.

Statistical analyses

Mean (SD) values of marginal and internal gap were calculated for all the tested groups. The Shapiro-Wilk test (Statistical software SPSS v. 25; SPSS Inc., Chicago, IL) was used to check the normality of data distribution, and the homogeneity of variances was examined using Levene test. The marginal and internal gap data for the different material-OT groups was found to be normally distributed ($P > .05$). 2-way analysis of variance (ANOVA) (SPSS v. 25) was used to statistically determine the effects of 'material' and 'occlusal thicknesses' on the marginal and internal gap ($\alpha = .05$). Bonferroni multiple comparison post-hoc tests (SPSS v. 25) were used to further analyze the differences between the individual 'material-OT' test groups (α=.05).

RESULTS

Table 1 presents the mean values for the marginal and internal gaps of resin nanoceramic RNC and LDS crowns, based on the two OTs. Across both thicknesses, the mean marginal gap for RNC crowns was 73 ± 16 µm, and the internal gap was 157 ± 7 µm. For LDS crowns, the corresponding values were 84 ± 19 µm (marginal gap) and 155 ± 12 µm (internal gap). The box plots illustrate the marginal and internal gap data for the different material-OT groups through five statistics, minimum, first quartile, median, third quartile, and maximum (Figs. 4 and 5).

Two-way ANOVA revealed a significant difference in marginal gap between RNC and LDS crowns ($p = .039$; Table 2), while no significant differences were found for the internal gap between the two materials ($p = .376$; Table 3). Regardless of material, occlusal thickness had a significant effect on both marginal and internal gaps ($p < .001$). However, the interaction effect between material and occlusal thickness was not significant for either marginal ($p = .758$) or internal gap ($p = .598$).

Bonferroni post-hoc comparisons (Table 4) further analyzed group-wise differences. For internal gaps, crowns with 0.5 mm and 0.75 mm OT differed significantly within both RNC and LDS groups ($p < .05$). For marginal gaps, a significant difference was found only between RNC crowns at 0.75 mm OT and LDS crowns at 0.5 mm OT ($p = .001$), while no significant differences were observed between the other material-OT combinations.

DISCUSSION

The results of this in vitro investigation, which evaluated the internal and marginal gaps of monolithic RNC crowns with LDS, were inconsistent. The marginal gap between the two materials differed significantly, although the internal gap differences were negligible. As a result, ~~some~~ part of the null hypothesis was accepted and ~~some were~~ part disproved. Regardless ~~of the kind~~ of the crown material, there were notable variations in both internal and marginal gaps when it came to the impact of occlusal thickness on crown fit accuracy. As a result, this null hypothesis was rejected.

RNC crowns demonstrated mean marginal gaps (73 ± 16 µm) comparable to those reported in earlier investigations, albeit with molar crowns (62 ± 25 µm

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and 59 - 97 µm).[26,28] with one study[26] reporting a broad range of marginal gaps. The possible reasons for the higher values could be due to the use of different nanoceramic material, 4-axis milling, and investigated abutment tooth type. The current results, however, differed with a previous paper[29] which showed markedly higher mean marginal gaps (92 ± 36 µm), although, absolute marginal discrepancies were examined in that study,[29] incorporating the negative or positive overhang elements to the marginal gap, possibly leading to the increased values.

As for the monolithic LDS crowns, the average marginal gap values (84 ± 19 µm) found in this study were closely relatable to the results of 2 previous investigations.[38,39] However, a few other studies did not concur with the current findings, where one found distinctly lower marginal gaps (28 µm),[40] in contrast with another[41] which reported distinctly higher marginal gap values (132 µm). The lesser marginal gaps might have resulted due to the differences in abutment tooth type, CAD-CAM milling system and scanner used, and the measurement technique employed.[40] The larger marginal discrepancies could have been caused due to the variations in the cement space settings, finish line configuration, milling and firing parameters, and post-milling crown finishing protocols followed.[41]

Contemporary literature[41,42] has noted the negative influence of crystallization process on the marginal fit of milled monolithic LDS crowns, although the differences might not always be clinically significant. The possible impact of 'firing' on the restoration fit was not investigated in this study; however, the effect of this factor cannot be ignored. Fully crystallized glass ceramic materials, including ZLS (zirconia lithium silicate) could be pitted against the hybrid nanoceramics to eliminate the potential effect of firing, after milling, in the future.

The findings of this study were corroborated by another investigation which found significant differences in the marginal gaps between RNC and LDS crowns,[29] albeit with molar crowns, fabricated from digital impressions using a different CAD-CAM system. The specific milling interactions of these materials possibly led to the observed differences in marginal gaps. It could be speculated that the RNC, due to its softer and somewhat elastic nature, enables milling burs to cut more aggressively and achieve the intended margin line with greater precision. This quality likely explains the smaller and more consistent marginal gaps observed in the RNC group. In contrast, LDS is harder and more brittle, which requires more conservative milling toolpaths to reduce the risk of chipping. This action often leads to marginal under-milling and, consequently, larger marginal gaps compared to RNC.[43]

The current results also contradicted a research paper[28] which showed insignificant differences between the two materials, in terms of marginal gap. Several factors could be linked to the disparity, including the milling unit type (4-axis milling), digital scanner and design software variations, crown occlusal thickness used (1.5 mm to 2 mm), and geometry and cervical curvature lines of the crowns, used in the other study.[28]

Significant differences were observed in this study, for both materials, in terms of marginal and internal gap, in relation to the crown occlusal thickness factor. A previous study[26] had reported similar findings for marginal gaps, but with different occlusal thicknesses. Lack of scientific literature, specifically related to the parameters used in this study, precluded further meaningful comparisons, with regards to the occlusal thickness effect, on fit accuracy. A previous investigation found that a reduction in occlusal thickness led to increased marginal and internal gap values, as thinner crowns exhibited greater susceptibility to flexure and seating inaccuracies.[43] Conversely, greater occlusal thickness enhanced resistance to deformation and facilitated more precise milling, thereby improving internal and marginal adaptation.[44] The tendency for higher marginal and internal gaps with decreased occlusal thickness was obvious in the current study, even though the quantitative differences in mean values were only 10-20 µm, for both the marginal and internal gaps. The clinical significance of these numbers on the outcome of the single crown prostheses is unknown but does not appear to be highly consequential.

The overall mean marginal gaps (pooled for both occlusal thicknesses) for RNC and LDS crowns were notably lower than 120 µm, suggested as a clinical threshold value for indirect restorations, by McLean and Fraunhofer.[24] The values were also close to the range of 65 - 80 µm, reported for CAD-CAM ceramic crowns, in a systematic review.[23]

The mean internal gaps found in this study for all the material– occlusal thickness groups were in the range of 147–162 µm. These values reconciled with the overall internal gap range of 50-190 µm seen in recent investigations comparing RNC with LDS monolithic crowns.[29,30] The values also fitted in the lower half of the mean internal gap range reported for CAD-CAM ceramic crowns (105–383 µm), in general, in a systematic review.[23] The greater gap widths observed in the occlusal region of the crown, compared to the axial wall space and marginal gap, are consistent with previous studies.[26,28-30] These site-specific differences are most likely attributable to the geometry and cutting dimensions of the milling burs.[45] Additionally, distortion during the scanning of the occluso-axial line angles of the tooth preparation with a laboratory scanner may also contribute to these findings.[16]

The choice of two occlusal thicknesses used in this study were based on previous reports[26,46] which found 0.7-0.8 mm OT monolithic ceramic crowns to be on par with the traditional thickness (1- 1.5 mm) RNC and LDS crowns, in terms of fracture resistance. So, minimal OT (0.5 mm) was tested alongside the 0.75 mm OT, in this investigation. Also, this study aimed to assess the fit accuracy of crowns made at reduced occlusal thicknesses, generally, due to deficient available data in the literature on this aspect.

Master metal die was used in this investigation to measure the fit of all 40 crowns, thus, standardising the parameter (abutment) across all tested groups. The use of cast metal die for crown fit evaluation was based on earlier studies.[16,31,33,41,47] which had adopted a similar approach. The silicone replica technique (SRT) employed in this investigation is a frequently used technique, reported in literature, for measuring the marginal fidelity of crowns.[31,34,35] A recent scoping review[35] had concluded that the SRT method yielded marginal gap results comparable to the contemporary double scan, triple scan, optical coherence tomography, and micro-computed tomography marginal gap evaluation methods.

A probable limitation of this study was related to the number of marginal gap evaluation sites used. Some studies have suggested assessment of 20 - 80 points around the circumference of the tooth, although majority have reported on 4 to 6 points on each crown specimen.[18,22,23,31,33,40] Additionally, the abutment tooth was prepared with a flat occlusal surface and a cervical finish line, which may not resemble every clinical situation. This preparation design may have possibly affected the results of this study. A single 5-axis milling machine in combination with a specific laboratory scanner and design software were used in the study. Results could have been different if other CAD-CAM systems were used.

Use of artificial intelligence (AI) for margin tracing in comparison with the present technique would be worthwhile considering the development and incorporation of AI in prosthodontic applications. Pitting the current RNC material with other contemporary RNC, PICN and ZLS materials would be useful, too. Furthermore, the effect of occlusal thickness on the fit of 3D printed crowns in relation to the milled types needs to be evaluated. Clinical studies assessing the marginal fit of RNC crowns are required to confirm the results of this laboratory study.

CONCLUSIONS

Within the limitations of the method used, the conclusions of this study are:

I. There were significant differences between the RNC and LDS crowns, in terms of marginal gaps ($P< .05$), but not for internal gaps ($P>.05$).
II. Occlusal thickness of crowns influenced both marginal and internal gaps, with reduced thickness producing higher marginal and internal gaps ($P< .05$).
III. Mean marginal and internal gaps of RNC and LDS crowns fall within the range shown in recent review papers.[22,23]

Conflict of Interest:

The authors have no conflicts of interest pertaining to the submitted manuscript.

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FIGURES

Figure 1. Master metal die- proximal view

Figure 2. Occlusal view of the silicone replica record demonstrating the design of cut sections for marginal and internal gap assessment: 1. mid-buccal (MidB); 2. mesio-buccal (MB); 3. mesio-palatal (MP); 4. mid-palatal (MidP); 5. disto-palatal (DP); 6. disto-buccal (DB) (specified through the red lines and corresponding numbers)

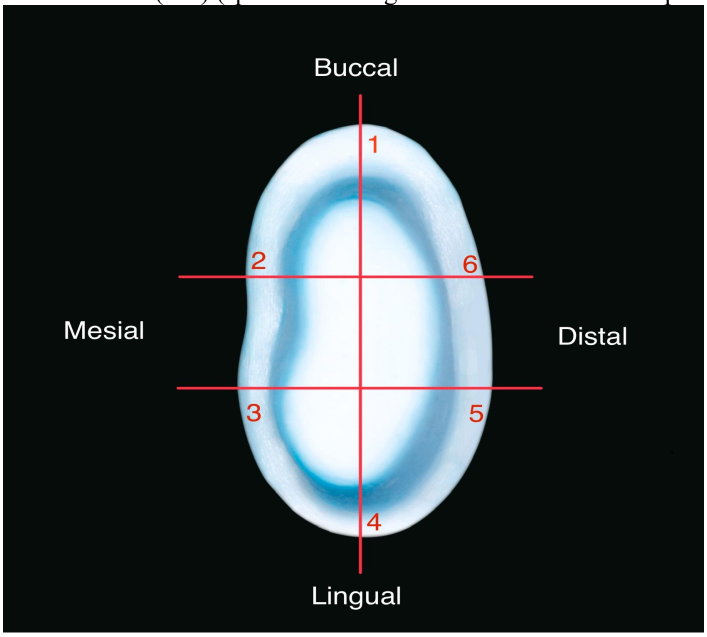


Figure 3. Stereomicroscopic image of the silicone replica cut section (identified by the white layer) for RNC crown showing the marginal and internal gap measurement scheme, on the axial and occlusal wall, with representative values. RNC, resin nanoceramic

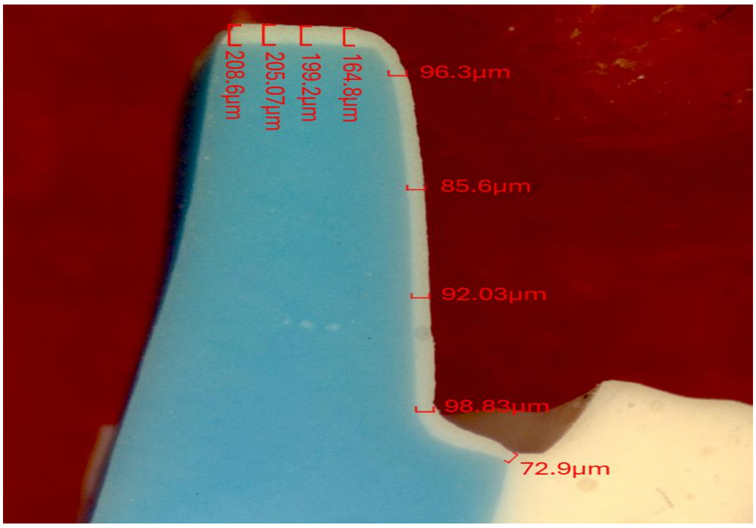


Figure 4. Box plot diagram showing distribution of marginal gaps (µm) across different material-occlusal thickness groups. RNC, resin nanoceramic; LDS, lithium disilicate; µm, microns; mm, millimeters.

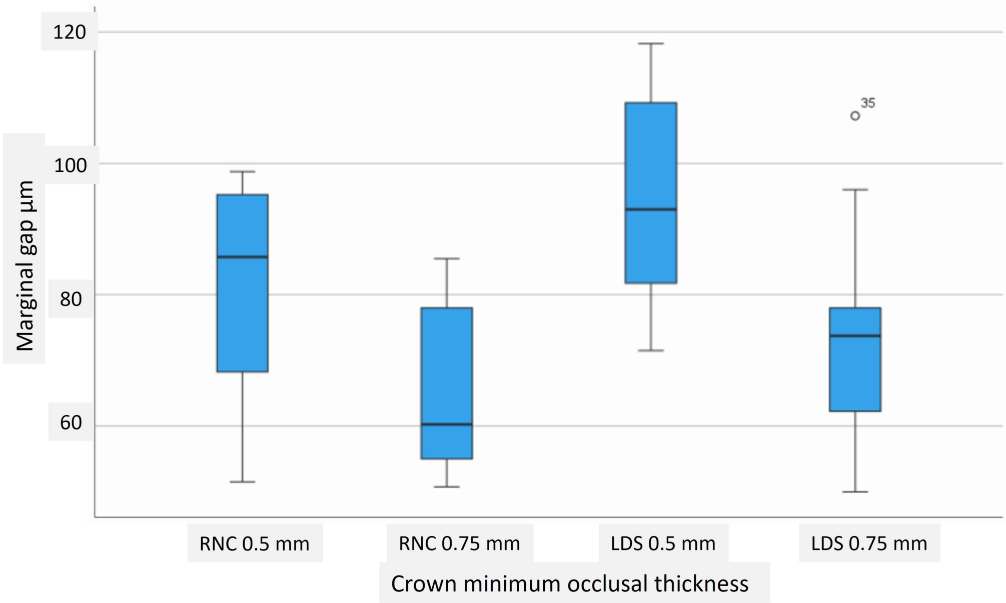
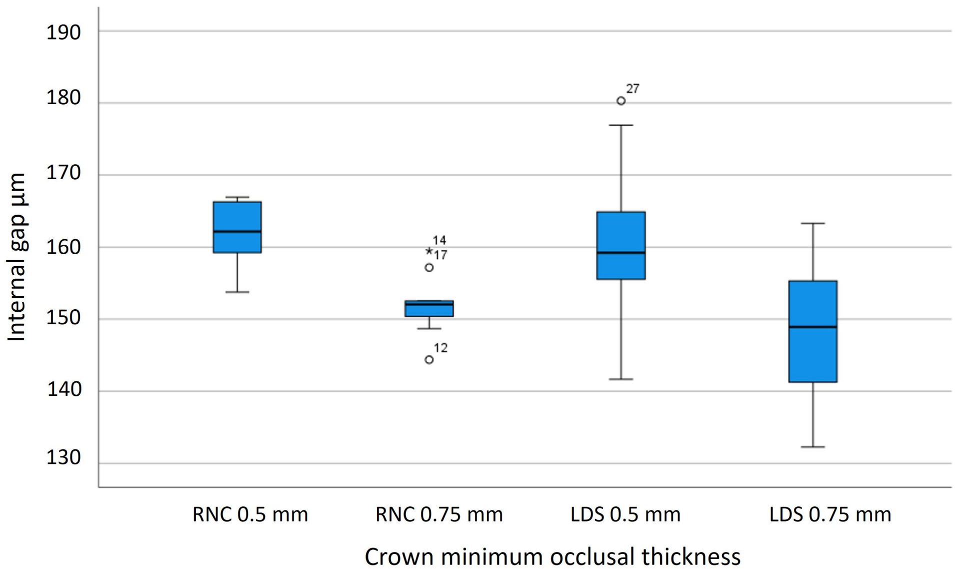


Figure 5. Box plot diagram showing distribution of internal gaps (µm) across different material-occlusal thickness groups. RNC, resin nanoceramic; LDS, lithium disilicate; µm, microns



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TABLES

Table 1. Mean (SD) of marginal gap and internal gap of resin nanoceramic (RNC) and lithium disilicate (LDS) crowns, by crown occlusal thickness (n=10)

Material	Marginal gap (µm)		Internal gap (µm)	
	0.5 mm	0.75 mm	0.5 mm	0.75 mm
RNC	81.55 (15.23)	65.25 (13.37)	162.02 (4.32)	151.96 (4.17)
LDS	93.62 (16.41)	74.27 (16.93)	161.12 (11.14)	148.40 (9.36)

Table 2. Two-way ANOVA comparing marginal gap between the two materials (RNC and LDS) and occlusal thicknesses [OT] (0.5 mm and 0.75 mm):

Variables of interest	Type III Sum of Squares	Df	Mean Square	F	Sig. (P)
Material RNC LDS	1113.03	1	1113.03	4.60	.039
Occlusal thickness (OT) 0.5 mm 0.75 mm	3177.31	1	3177.31	13.14	<.001
Material × Occlusal thickness (OT)	23.26	1	23.26	.096	.758

Table 3. Two-way ANOVA comparing internal gap between the two materials (RNC and LDS) and occlusal thicknesses [OT] (0.5 mm and 0.75 mm):

Variables of interest	Type III Sum of Squares	Df	Mean Square	F	Sig. (P)
Material RNC LDS	49.738	1	49.738	.802	.376
Occlusal thickness (OT) 0.5 mm 0.75 mm	1297.226	1	1297.226	20.922	<.001
Material × Occlusal thickness (OT)	17.556	1	17.556	.283	.598

Table 4. Multiple comparisons for marginal and internal gap, Bonferroni post-hoc test, based on observed means

-	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
MARGINAL GAP	RNC-0.5 mm	RNC-0.75 mm	16.30000	6.95374	.148	-3.1146	35.7146
		LDS-0.5 mm	-12.07500	6.95374	.546	-31.4896	7.3396
		LDS-0.75 mm	7.27500	6.95374	1.000	-12.1396	26.6896
	RNC-0.75 mm	RNC-0.5 mm	-16.30000	6.95374	.148	-35.7146	3.1146

		LDS-0.5 mm	-28.37500*	6.95374	.001	-47.7896	-8.9604
		LDS-0.75 mm	-9.02500	6.95374	1.000	-28.4396	10.3896
	LDS-0.5 mm	RNC-0.5 mm	12.07500	6.95374	.546	-7.3396	31.4896
		RNC-0.75 mm	28.37500*	6.95374	.001	8.9604	47.7896
		LDS-0.75 mm	19.35000	6.95374	.051	-.0646	38.7646
	LDS-0.75 mm	RNC-0.5 mm	-7.27500	6.95374	1.000	-26.6896	12.1396
		RNC-0.75 mm	9.02500	6.95374	1.000	-10.3896	28.4396
		LDS-0.5 mm	-19.35000	6.95374	.051	-38.7646	.0646
INTERNAL GAP	RNC-0.5 mm	RNC-0.75 mm	10.06458*	3.52146	.042	.2328	19.8964
		LDS-0.5 mm	.90521	3.52146	1.000	-8.9266	10.7370
		LDS-0.75 mm	13.61979*	3.52146	.003	3.7880	23.4516
	RNC-0.75 mm	RNC-0.5 mm	-10.06458*	3.52146	.042	-19.8964	-.2328
		LDS-0.5 mm	-9.15937	3.52146	.080	-18.9912	.6724
		LDS-0.75 mm	3.55521	3.52146	1.000	-6.2766	13.3870
	LDS-0.5 mm	RNC-0.5 mm	-.90521	3.52146	1.000	-10.7370	8.9266
		RNC-0.75 mm	9.15937	3.52146	.080	-.6724	18.9912
		LDS-0.75 mm	12.71458*	3.52146	.006	2.8828	22.5464
	LDS-0.75 mm	RNC-0.5 mm	-13.61979*	3.52146	.003	-23.4516	-3.7880
		RNC-0.75 mm	-3.55521	3.52146	1.000	-13.3870	6.2766
		LDS-0.5 mm	-12.71458*	3.52146	.006	-22.5464	-2.8828