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EVALUATION OF MARGINAL DISCREPANCY AND MICROLEAKAGE OF LAVA ULTIMATE (RESIN NANO CERAMIC) VERSUS LITHIUM DISILICATE (IPS E.MAX CAD) ENDOCROWNS. IN VITRO STUDY

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ABSTRACT

Extra coronal restoration for endodontically treated teeth is preferable. Endocrowns have become a promising alternative in the functional recovery of endodontically treated molar teeth. Lava Ultimate Resin Nano Ceramic (RNC) blocks express the unique biomechanical complex (monoblock). Reducing the marginal discrepancies and microleakage of a restoration is attained by preventing the luting material from dissolution and exposure to oral environment. Natural teeth were assigned into 2 groups according to the material of endocrowns. Group 1: (4 each): LAVA Ultimate. Group 2: (4 each) E.Max CAD. The crown portion of all molars were removed perpendicular to the long axis and subjected to standard endodontic treatment. Scanning, designing and milling of endocrown restorations corresponding to each tooth preparation. Endocrowns were cemented and thermocycled. Each specimen was photographed using USB Digital microscope with a built-in camera. A digital image analysis system was used to measure and qualitatively evaluate the gap width. Dye penetration depth was measured with using USB Digital microscope with the built-in camera. It was found that E.max group recorded higher vertical marginal gap mean value (76.99 ± 5.04 µm) than Lava Ultimate group (69.51 ± 7.1 µm) and was statistically non-significant (P>0.05) as indicated by student t-test. The vertical marginal discrepancy of the E.max CAD and Lava Ultimate endocrowns fall within the clinically acceptable range <120 µm.

KEYWORDS : E.max CAD, endocrowns, Lava Ultimate, Marginal discrepancy, Microleakage, CAD/CAM

Extra coronal restoration for endodontically treated teeth is preferable as the tooth has lost its strength by previous caries, trauma, access cavity preparation rather than dehydration or physical changes in the dentin. Endocrowns have become a promising alternative in the functional recovery of endodontically treated molar teeth. Endocrowns attain their retention from the great surface area of the pulp chamber. They thereby, reduce the weakening effect resulted by the post space preparation. CAD/CAM technology introduces new materials that are based on bonding with resin cement, resulting in restorations that are fabricated faster, decreasing chair-side time of the dentist efficiently (e.g.: restoration with good performance, esthetics, function & hygiene) in a more conservative way, under optimum conditions, higher intrinsic strength and with an acceptable fit of 50 µm (Santos et al., 2013). Moreover, Lava Ultimate Resin Nano Ceramic (RNC) blocks are inventive new CAD/CAM materials. Lava Ultimate consists of about 79 wt. % nano ceramic particles that reinforce a highly cross linked polymeric matrix. It has an elastic modulus comparable to dentin, which is much lower than what brittle glass ceramic materials provide, resulting in excellent machinability and therefore better marginal quality than glass ceramics including lithium disilicate. They also express the unique biomechanical complex (monoblock) where tooth and restoration become a single structure distributing stresses more evenly to all constituents. It was found worth to study the marginal discrepancy and microleakage of Lava Ultimate (Resin nano ceramic) endocrowns versus Lithium disilicate (IPS E.max CAD) endocrowns.

MATERIALS AND METHODS

The materials used in this study were: 1] IPS E.Max ™ CAD Ivoclar Vivadent blocks. 2] Lava Ultimate 3M ESPE ™ blocks. 3] Adhesive resin cement (Rely X Ultimate). Teeth Selection criteria: A total of 8 human molars were selected with similar root lengths and crown dimensions after measuring the B-L and M-D widths at CEJ in mm. Sample size calculation: The plan of this in-vitro study was of a continuous response variable (microleakage) from CAD/CAM endocrowns (E-MAX) and CAD/CAM endocrowns (LAVA ULTIMATE) with 1 control(s) per experimental subject. If the true difference in the experimental and control means was 0.89, it was a must to study 4 experimental subjects and 4 control subjects to be

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able to reject the null hypothesis that the population means of the experimental and control groups are equal with probability (power) 0.9. The Type I error probability associated with this test of this null hypothesis was 0.05. Implementation of allocation was done as follows: Number from 1:8 was written on folded papers and was placed in opaque sealed envelopes. The samples were numbered from 1 and ascending and then were divided by the website (http://www.random.org/) into 2 equal divisions. All teeth were mounted in epoxy resin blocks using custom made Teflon mold (2.5 diameter x 2.5 height) (Figure, 1). A special device (paralleling device) was fabricated to allow accurate vertical centralization of the tooth in the Teflon mold during construction of the epoxy resin blocks. The crown portion of all molars were removed perpendicular to the long axis to within 2.5mm above the CEJ at the buccal and lingual sides and 2 mm from the CEJ in the proximal sides, using coarse diamond disc and copious water irrigation forming a butt joint design.

All teeth were subjected to standard endodontic treatment. Superior aspect of Gutta percha was removed till the canals entrance with no more than 1 mm below the orifice of each canal drilling inside the canals. A thin layer of flowable composite material (tg flow London, United Kingdom) was applied to seal any undercuts meanwhile enhance bonding with resin cement. A CAD/CAM system Cerec AC system with Omnicam (Sirona Dental systems

Figure 1 : Teeth Mounted in Epoxy Resin Blocks Using Custom Made Teflon Mold

GmbH, Bensheim, Germany) and MCXL in lab milling machine were used for the fabrication of all samples in this study. To obtain a three dimensional image for each prepared tooth on the computer screen of the Cerec AC system, 4.0.1 software system, the prepared tooth was scanned using the omnicam scanner. The data was generated successively into a 3D model then the captured pictures (Figure, 2) were saved in the preparation catalogue of the software. The Programat P300 furnace was used for crystallization and glaze firing. The IPS e.max CAD

Figure 2 : Virtual Restoration Design.

ceramic endocrowns appeared to be in their precrystallized form after milling where they have the bluish grey colour. For the lava ultimate, no firing was needed. Finishing and polishing of the Lava Ultimate endocrowns were performed by Meisinger Tool Set extra oral finishing and polishing system. The intaligo surfaces of each E.max CAD endocrown were etched with 4.9% hydrofluoric acid (HF) etching gel for 20 seconds according to manufacturer's instructions. Using a mini brush, Scotchbond Universal Adhesive (the primer and adhesive are in one bottle) was applied to the entire fitting surface, left for 20 sec. then gently air thinned with moisture-free air for 5 seconds until the solvent evaporated and the adhesive no longer moved over the surface. Lava Ultimate endocrowns were cleaned in an ultrasonic cleaner and were gently blowed dry with air. Sandblasting of the internal fitting surfaces of lava ultimate endocrowns was performed with aluminum oxide ≤50 μm (Cojet) at two bar (30 psi) pressure, according to the manufacturer's instructions, until the entire bonding surface appeared matt. The Lava Ultimate is not indicated for etching with HF or phosphoric acid. The Scotchbond™ Universal Adhesive was applied for 20 seconds, then dried with air for 5 seconds. The prepared surfaces of the tooth were acid etched using 37% phosphoric acid for 15 seconds then rinsed for 20 seconds. Gentle air dryness was performed on the etched tooth surfaces to avoid dentin over dryness. The adhesive was applied and allowed to dwell for 20 seconds. It was thinned and the solvents were evaporated for 5 seconds with a steady stream of air and then light-cured for 20 seconds. Each of the E.max endocrown and the Lava Ultimate endocrown were seated on its respective tooth with finger pressure, and excess cement was carefully removed from the margins, then a glycerin gel was applied to the border surfaces for oxygen inhibition according to the manufacturer's instructions. A customized loading device was then used to apply a standardized load of 5 Kg parallel to the long axis of each endocrown to prevent rebounding of the endocrown during cementation then light curing was applied to all surfaces for 20 seconds per surface. The cemented samples were stored in distilled water at 37ºC for 7 days. Using a thermocycling device the cemented cycles were thermocycled. The number of cycles used was 500 cycle according to ISO standardization. Dwell times were 25sec. in each water bath with a lag time 10 sec. The low-temperature point was 5°C. The high-temperature point was 55°C. Following cementation, each specimen was photographed using USB Digital microscope with a built-in camera (Scope Capture Digital Microscope, Guangdong, China) connected with an IBM compatible personal computer using a fixed magnification of 40X. Shots of the margins were taken for each specimen. Then morphometric measurements were done for each shot [5 equidistant landmarks] along the cervical circumference for each surface of the specimen (Mesial, buccal, distal, and lingual). Measurement at each point was repeated five times. The entire surface of each specimen was covered with two coats of varnish up to 1mm from the crown margins. The samples were immersed into 0.5% methylene blue (M.B) solution for 24 hours at room temperature in an incubator at 37° C. Following dye exposure, the teeth were rinsed thoroughly with a water syringe for 30 seconds. They were sectioned in B-L direction. Dye penetration depth was measured with using USB Digital microscope with a built-in camera.

RESULTS

Data analysis was performed in several steps. Initially, descriptive statistics for each group results. Student t-test was done between endocrown type groups. Statistical analysis was performed using Aasistat 7.6 statistics software for Windows (Campina Grande, Paraiba state, Brazil). P values ≤0.05 are considered to be statistically significant in all tests.

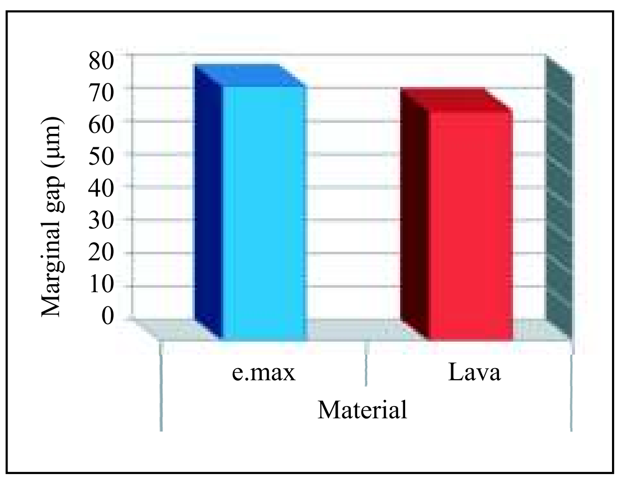

Figure 3 : Column Chart of Vertical Marginal Gap Mean Values as Function of Material

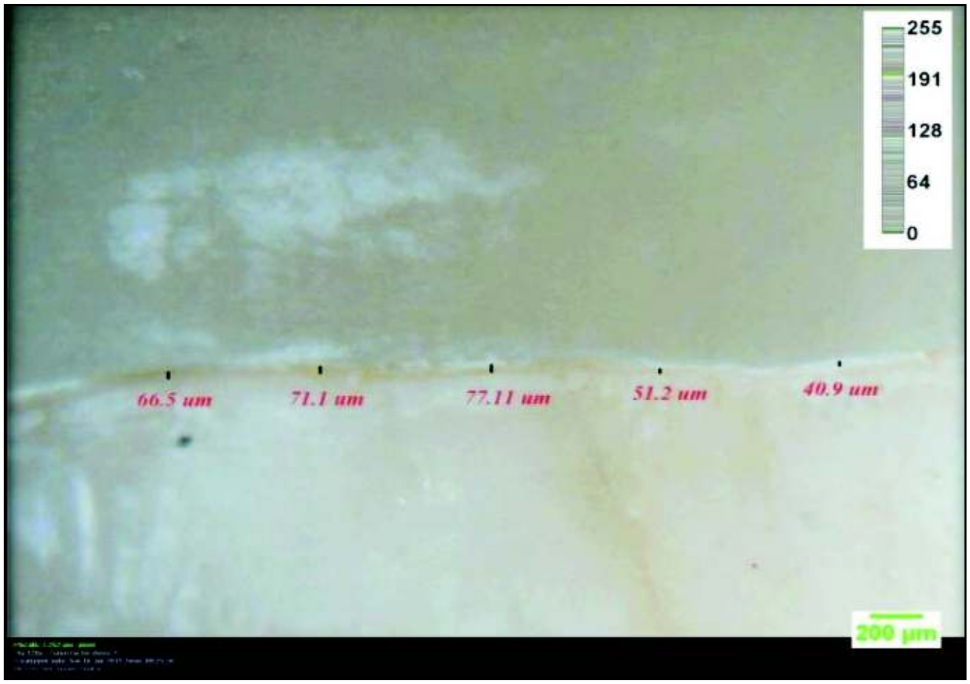

Figure 4 : Representative Microscopic Image Showing Margin Evaluation by Vertical Marginal Discrepancy Distance Measurement of Lava Ultimate

Figure 5 : Representative Microscopic Image Showing Margin Evaluation by Vertical Marginal Discrepancy Distance Measurement of the e. max

Table 1 : Comparison Between Vertical Marginal Gap Results (Mean values± SDs) as Function of Material

Variables		Mean µm	*SD*	Rank	Statistics (p value)
Material	e.max	76.99	5.04	A	0.0625 ns
	Lava	69.51	7.1	A	

Different letter in the same column indicating statistically significant difference ($p < 0.05$)
*; significant ($p < 0.05$) ns; non-significant ($p>0.05$)

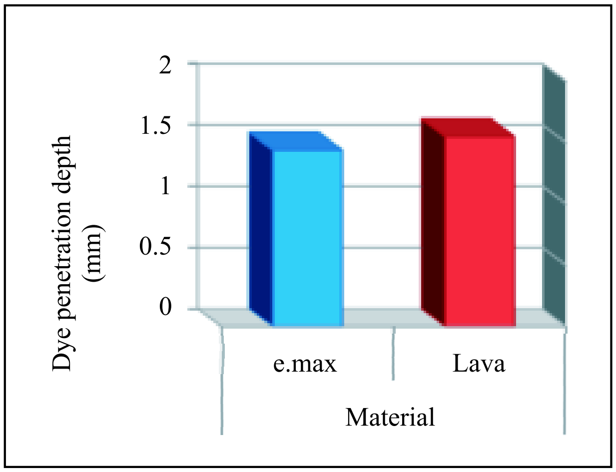

Figure 6 : A column Chart of Dye Penetration Depth Mean Values as Function of Material

Vertical Marginal Discrepancy

The mean values and standard deviation of vertical marginal gap (µm) for both groups are summarized in table 1 and graphically drawn in (Figure, 3) and representative microscopic images of the vertical marginal discrepancy in (Figures 4 & 5). It was found that e.max group recorded higher vertical marginal gap mean value (76.99 ± 5.04 µm) than Lava group (69.51 ± 7.1 µm). The difference of vertical marginal gap means values between both groups was statistically non-significant (P>0.05) as indicated by student t-test.

Microleakage

The mean values and standard deviation of microleakage measured by dye penetration depth (mm) for

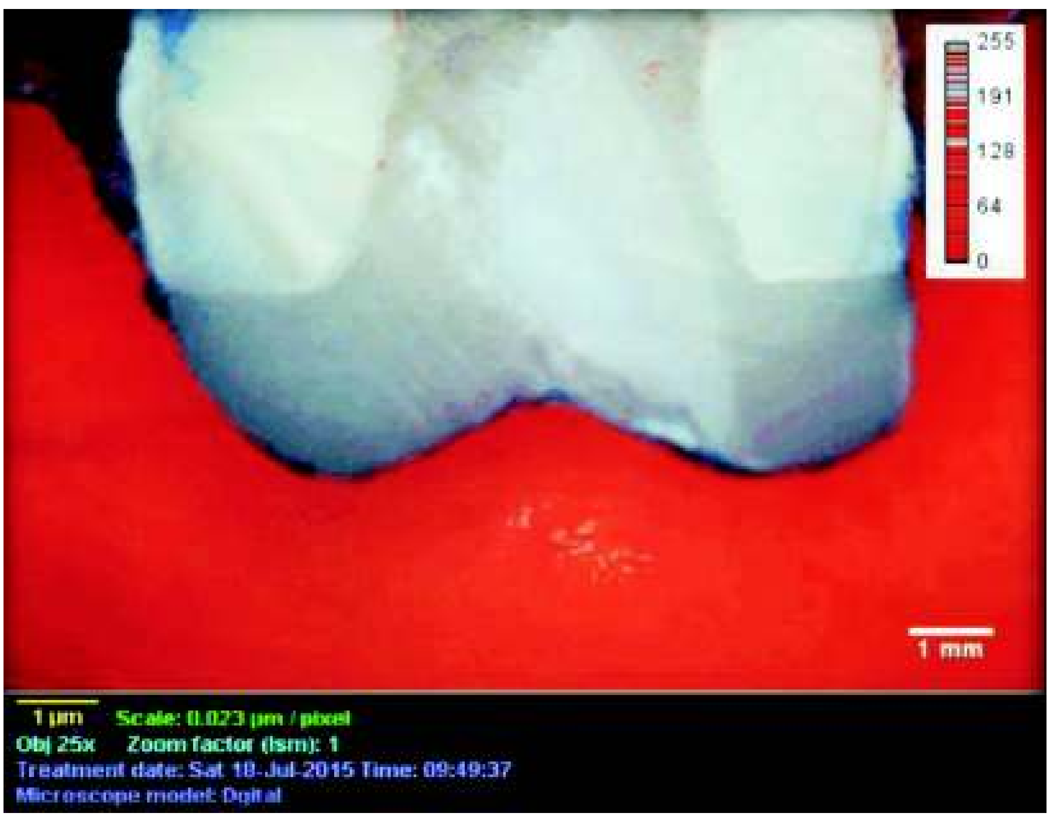

Figure 7 : Representative Microscopic Image Showing 0-Microleakage Evaluation by Dye Penetration Depth

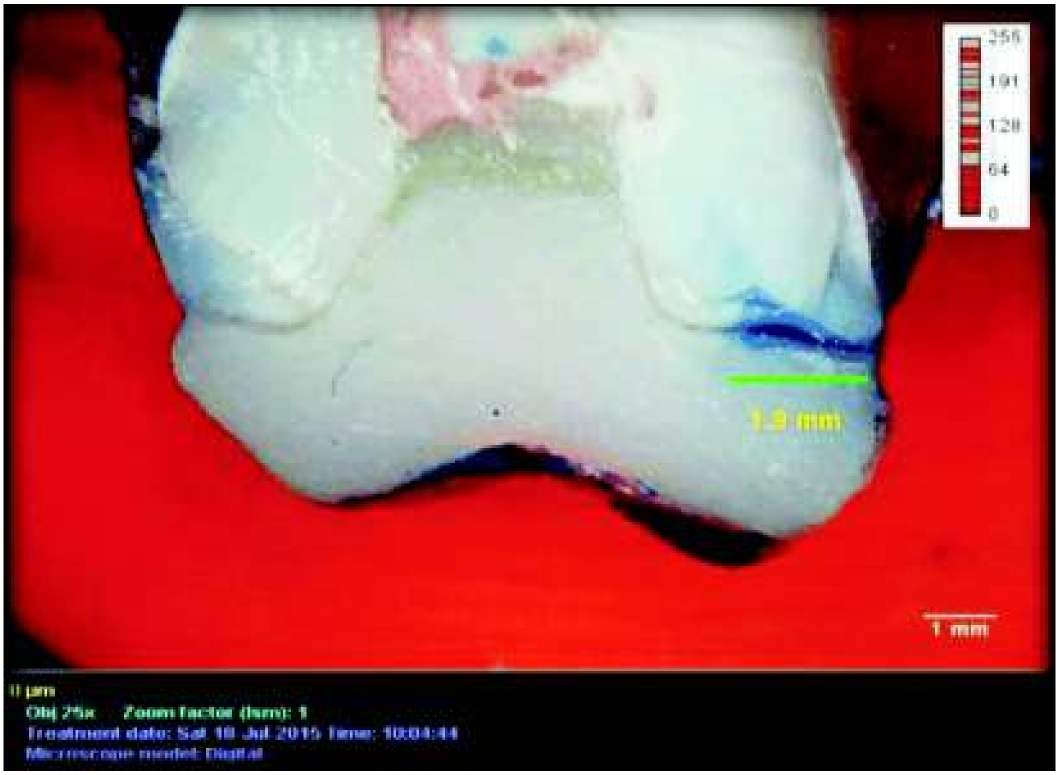

Figure 8 : Representative Microscopic Image Showing Microleakage Evaluation by Dye Penetration Depth Measurement (e.max Group)

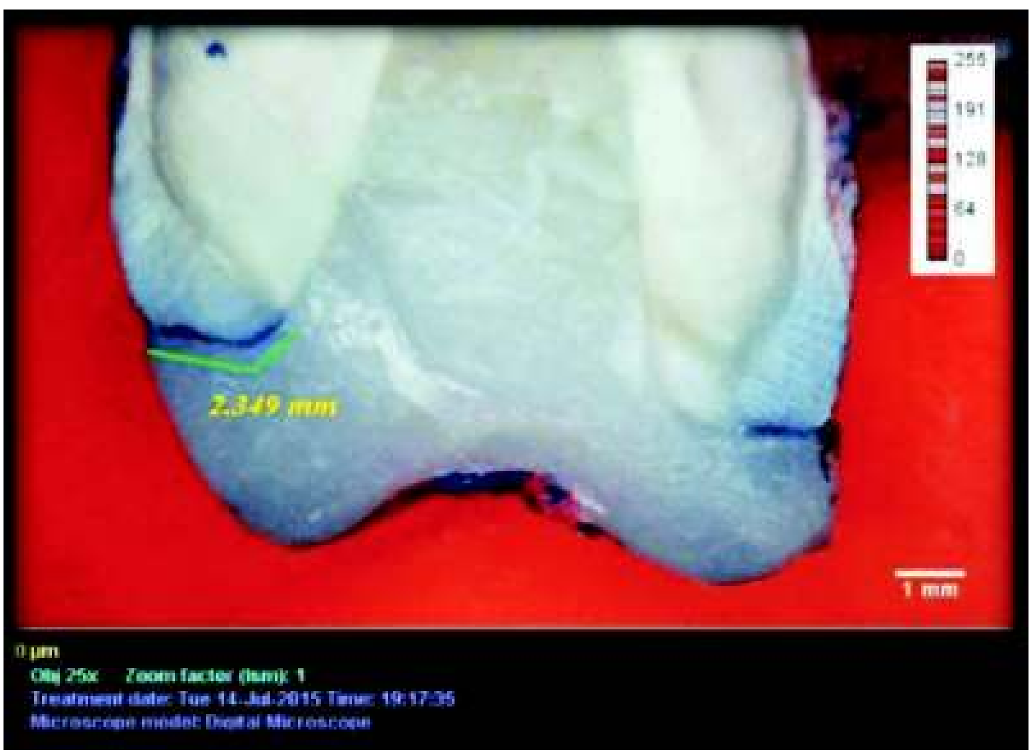

Figure 9 : Representative Microscopic Image Showing Microleakage Evaluation by Dye Penetration Depth Measurement (Lava Group)

Table 2 : Comparison Between Dye Penetration Depth Results (Mean values± SDs) as Function of Material

Variables		Mean µm	SD	Rank	Statistics (p value)
Material	e.max	1.44	0.31	A	0.853 ns
	Lava	1.55	0.48	A	

Different letter in the same column indicating statistically significant difference ($p < 0.05$)
*; significant ($p < 0.05$) ns; non-significant ($p>0.05$)

both groups are summarized in table 2 and graphically drawn in (Figure, 6) and representative microscopic images showing microleakage evaluation by dye penetration depth measurement in (Figures 7, 8 &9). It was found that Lava Ultimate group recorded higher dye penetration depth mean value (1.55 ± 0.48 mm) than e.max group (1.44 ± 0.31 mm). The difference of dye penetration depth means values between both groups was statistically non-significant (P>0.05) as indicated by student t-test.

DISCUSSION

Endocrowns preserve tooth tissues, keep all margins of the restoration away from the periodontium, which is beneficial for hygiene and periodontal health, and eliminate many technical steps during the fabrication. The utilization of the available space inside the pulp chamber adds to the stability and retention of the restoration. (Biacchi & Basting, 2012). It was thereby necessary to investigate the marginal quality of different endocrown materials by evaluating their marginal discrepancy and microleakage, as the marginal quality has direct effect on the success of any restoration. IPS e.max CAD blocks were chosen as a control because they have the advantages of long term clinical acceptability, good bonding characteristics, short laboratory steps, favorable esthetics, high strength, good edge stability(S. & S. 2014). Lava Ultimate Resin Nano Ceramic (RNC) blocks was chosen as they are inventive new CAD/CAM materials. The Lava Ultimate has an elastic modulus of approximately 12.7 GPa which is comparable to dentin (13-15 GPa) so monoblock effect is also attained, which allows for uniform stress distribution in the tooth-restoration complex they act as one unit (Hassan et al., 2012). It's generally agreed that resin cement bonding to the tooth and crown through both chemical and micromechanical bonding decreases the marginal discrepancy and thereby the microleakage. In addition it acts as inherent buffering layer that is able to absorb stresses during load application (Gu & kern, 2003). Thermal cycling was performed for all specimens to mimic the oral conditions. The International Organization for Standardization (ISO) recommends thermal cycling between 5°C and 55°C as an accelerated aging test (Schmid-Schwap et al., 2011). The vertical marginal gap measurement was selected as the most frequently used method to quantify the accuracy of a restoration (Groten et al., 1997). The measurement was performed at 20 points along the cervical circumference of each endocrown.

The findings were in accordance with Awada and Nathanson (Awada & Nathanson, 2014) who reported improved marginal quality of Lava Ultimate restorative material, Enamic, Cerasmart (polymer based CAD/CAM materials) than IPS Empress CAD, Vitablocs Mark II (ceramic counterpart). This is probably due to the reduced brittleness of these materials compared with conventional ceramics and the effect of diamond milling instruments. According to some workers crowns that were milled from resin nano ceramic (Lava™ Ultimate Restorative) had a better fit than the glassceramic (IPS® e.max® CAD) , indicating that there is an important difference between the machining ability of these materials. Unlike the other ceramics, Lava Ultimate contains 80% nanoceramic particles embedded in a highly cured resin matrix (20%). It is thought that this unique composition results in a higher coefficient of thermal expansion in comparison to that of ceramic materials with the dentin. The linear coefficient of thermal expansion has been suggested as an important factor that influences microleakage. Thereby, the results of this study were in accordance with (EL-Damanhoury et al., 2015) in which the microleakage was more in the Lava ultimate endocrowns in comparison to e.max CAD. Also, the results of (Ghazy et al., 2010) were in accordance with this study which showed insignificant difference in microleakage between porcelain (Vita Mark II, Vident) and composite (Paradigm MZ100, 3M ESPE). The low stiffness properties of these materials (polymer based CAD/CAM materials) could be considered disadvantageous, as marginal seal debonding due to flexure might occur which would lead to increased microleakage. The first and second null hypotheses were thereby accepted due to the insignificant differences in the results of the marginal discrepancy and the microleakage tests.

CONCLUSION

The vertical marginal discrepancy of the E.max CAD and Lava Ultimate endocrowns fall within the clinically acceptable range <120 µm. E.max CAD is considered the gold standard for the construction of endocrowns, although, the Lava Ultimate is clinically acceptable in terms of marginal discrepancy and microleakage.

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