Journal of medical & pharmaceutical Sciences
Volume (5), Issue (4): 30 Dec 2021
P: 65 - 80
ISSN: 2522-333X
مجلة العلوم الطبية والصيدلانية
المجلد (5)، العدد (4): 30 ديسمبر 2021 م
ص: 65 - 80

FRACTURE RESISTANCE UNDER CYCLIC LOADING OF LITHIUM DISILICATE VONLAYS VERSUS ROSETTA VONLAYS RESTORING PREMOLARS (IN VITRO STUDY)

Mahmoud Showky Mohammed Ahmed
Rasha Nabil Sami
Noha Adel El Khodary
Faculty of Dentistry || Cairo University || Egypt

Abstract: The aim of the study was to assess fracture resistance under cyclic loading of Rosetta®SM CAD vs. IPS e.max CAD (control) vonlays restoring maxillary premolars.

According to the sample size calculation, a total of 20 samples will be selected and then divided into two equal groups; 10 sample each based on the material type:

Group (A): Ten vonlays (n=10) manufactured from IPS e. max CAD blocks (control).

Group (B): Ten vonlays (n=10) manufactured from Rosetta®SM CAD blocks (intervention).

A natural tooth presenting an upper first premolar was prepared in accordance with the ceramic onlay restorations preparation guidelines with an occlusal box with half of the bucco-lingual distance and a 2 mm depth from the cusp tip to pulpal floor, gingival seat with 1 mm depth from pulpal floor, occlusal reduction of 2 mm of the functional cusp with extending the preparation at the palatal surface by 2 mm in the cervical direction, occlusal reduction of 1.5 mm of non-functional cusp and 12° divergence angle. The preparation was then extended to the labial surface, with a 0.5 mm chamfer finish line. All line angles were finally rounded, and all margins were finished.

For duplication of the natural tooth; the epoxy dies were constructed. Base and catalyst of the epoxy resin material were mixed as instructed by the manufacturer at a rate of 200r/min and then was poured into the silicon mould under vibration to eliminate any air voids, then was allowed to set completely following the manufacturer instructions for 24 hours, this procedure was repeated 20 times for creating 20 epoxy resin dies which replicating the prepared natural tooth.

The die was then scanned by optical scanning using Medit i500 oral scanner. Milling of Vonlays was achieved using Sirona MCX5 milling machine using IPS e. max CAD blocks and Rosetta SM CAD blocks: 10 IPS e.max CAD blocks with block size C14 and 10 Rosetta®SM CAD blocks with block size C14 were used.

Vonlays were then seated on their corresponding dies and cemented with dual cured self-adhesive resin cement (Variolink, Ivoclar Vivadent). Cementation procedures were performed by keeping each sample under a constant pressure of 5Kg using a custom designed cementation device for standardization the applied load during cementation process.

All samples were mechanically aged (cyclic loading) to simulate 6 months of clinical use. Following that, all samples were subjected to fracture resistance testing under a compressive load to the center of their long axis using computer controlled universal testing machine with a load cell of 5 Kilo newton (K N) with a computer software used for data recording (Instron® Bluehill Lite Software).

The mean values ± SDs values for e.max group were (502.39 ±102.89 N) with minimum value (338.16 N) and maximum value (721.29 N). The mean values ± SDs values. Rosetta group were (468.76 ± 67.54 N) with minimum value (367.11 N) and maximum value (648.48 N).

Failure modes were determined under stereomicroscope and classified into repairable and catastrophic in both groups and showed that 60% of e.max group exhibited repairable failure while 40% of specimens showed catastrophic failure while in Rosetta group, 90% of the specimens exhibited repairable failure. Only 10% displayed catastrophic failure.

Then a fractured part within each group was examined under scanning electron microscope (SEM) to reveal and compare their microstructure.

Keywords: onlay, veneer, fracture strength, fracture resistance, cyclic loading, E.max CAD and Rosetta®SM CAD.

مقاومة الكسر للقشور السطحية الخزفية المرممة للضواحك تحت تحميل دوري والمصنعة من الليثيوم ديسليكات مقابل القشور السطحية الخزفية المصنعة من الروزيتا: دراسة معملية

محمود شوقي محمد احمد

رشا نبيل سامي

نهى عادل الخضري

كلية طب الأسنان || جامعة القاهرة || مصر

المستخلص: كان الهدف من هذه الرسالة هو تقييم مقاومة الكسر تحت تحميل دوري للضواحك المرممة بالقشور السطحية الخزفية المصنعة من الليثيوم ديسليكات بالمقارنة مع القشور السطحية الخزفية المصنعة من الروزيتا والمصنعين بتكنولوجيا التصميم والخرط بالتحكم الحاسوبي.

طبقا لعملية حساب عدد العينات تم تصنيع عشرين عينة من القشور السطحية الخزفية وتم تقسيمها عشوائياً إلى مجموعتين على حسب نوع المادة (عشر عينات في كل مجموعة):

المجموعة الأولى: عشر عينات بتكنولوجيا التصميم والخرط الحاسوبي التحكم من مادة الليثيوم دايسيليكات (ايماكس كاد).

المجموعة الثانية: صنعت عشر عينات بتكنولوجيا التصميم والخرط الحاسوبي التحكم من مادة الروزيتا.

تم تحضير ضاحك من الأسنان الطبيعية تمثل الضاحك الأول للفك العلوي طبقاً للمعايير والقياسات المتفق عليها لتركيبات البورسلين الكاملة ثم تم عمل عشرين نسخة طبق الأصل من الضاحك الطبيعي وذلك بعمل قالب من مادة السيليكون للمطابقة ومن ثَم ملؤه بمادة راتنجات الإيبوكسي وتركها لتتصلب بالوقت الموصى به لتأخذ شكل الضاحك.

تم عمل مسح ضوئي لكل نسخة من الضاحك المصنع من مادة راتنجات الإيبوكسي المحضرة باستخدام ماسح ضوئي.

تم عمل خرط للعينات الخاصة بكل من المادتين المستخدمتين بواسطة ماكينة الخرط من النوع سيرونا ام سي اكس خمسة وذلك باتباع التعليمات والطرق الموصى بها من المصنع.

تم تنظيف العينات ومعالجة السطح الداخلي للتيجان بالمواد المخصصة لذلك. ثم تم وضع القشور السطحية الخزفية على النسخ المخصصة لها ومن ثَم لصقها بواسطة لصق الراتينج ثنائي التصلب. أثناء اللصق؛ تم الحفاظ على العينات تحت الضغط المستمر باستخدام وزن ثابت (5 كجم) المثبت في جهاز التحميل المصمم خصيصاً وذلك لتوحيد التحميل أثناء عملية اللصق. ثم بعد ذلك تم تعريض العينات لضغط دوري بعدد دورات تحاكي ستة أشهر من المضغ داخل الفم.

تم اختبار مقاومة التكسر لجميع العينات تحت قوة ضاغطة تم توجهها على طول المحور الطولي للعينات بواسطة ماكينة اختبار عالمي متصلة بجهاز تحكم حاسوبي يتضمن وحدة ثقل تعادل (5 نيوتن). ثم يتم وضع الاختبار عن طريق قضيب معدني ذو طرف مستدير قطره

(3.8 ملليمتر) مثبت على الجزء العلوي لجهاز الاختبار ويتحرك بسرعة (1 ملليمتر لكل دقيقة). ثم تم جمع البيانات لكل مجموعة من العينات وجدولتها وتحليلها احصائياً.

ثم تم عمل فحص بالميكروسكوب الإلكتروني للجزء المكسور لكل من العينيتين لمقارنة البنية المجهرية لكلٍ منهما.

أظهرت النتائج ما يلي:

أنه لا يوجد هناك فروق احصائية ملحوظة بين المجموعتين المختبرتين؛ مع وجود اختلاف بسيط في البنية المجهرية مجموعة الروزيتا يجعل مقاومتها للكسر قابلة للإصلاح بالمقارنة بمجموعة الإيماكس.

الكلمات المفتاحية: البطانة، القشرة، مقاومة الكسر، مقاومة الكسر، التحميل الدوري.

Introduction:

Because of the development of modern high strength ceramic materials like lithium disilicate and manufacturing processes such as heat pressing and CAD/CAM, dental personnel will now produce extremely esthetic, high-strength restorations that match the natural dentition perfectly while withstanding occlusal forces in occlusal teeth.

Porcelain veneers have long been popular restorative options, evolving into such a widely accepted treatment that could be created with a variety of methods. Onlays are also another common treatment option of modern dentistry for restoring large carious areas and replacing defective restorations. As a result, creative ways of delivering minimally invasive dentistry have developed. Such a concept is called "vonlay" which is a combined restoration as explained in this thesis. Vonlays could be used as an alternate to complete coverage crowns to restore defective posterior teeth especially premolars.

Ceramics are available into two types: bilayered and monolithic. Differences in stress distribution and coefficient of thermal expansion between layers cause a weak bond between the veneer and the framework in bilayered ceramics, which is associated with a high occurrence of chipping and delamination of veneers from the inner core.

STATEMENT OF THE PROBLEM

Partial-coverage adhesive all-ceramic restorations have been widely used for making posterior restorations rather than traditional full coverage which still considered to be invasive methods that could weaken tooth structure and consequently lowering fracture resistance.

Lithium disilicate has been thought to be the strongest glass ceramic material. Because of the large number of microstructural; interlocking, spindle-like lithium disilicate crystals found in the glassy matrix, this kind of ceramic has better mechanical properties than other varieties of glass-based ceramic material, but mechanical properties limit its use with thin sections in high stress-bearing areas.

In an effort to enhance the optical and mechanical properties of glass-ceramic materials; more alternatives for lithium disilicate have been developed for CAD/CAM technologies.

Materials and methods.

Sample size calculation:

Sample size calculation was done using R statistical package, version 3.3.1 (21-06-2016). Copyright (C) 2016. The R Foundation for Statistical Computing.

Paired T test power calculation was used to detect the proper sample size. Mean differences and standard deviations were estimated according to (Schwindling et al. 2017) according to the test force at vonlay fracture. The sample size calculation was based on a conservative mean difference of 18 Newton.

The results revealed that a total sample size of 20 vonlays will be adequate to detect a mean difference between study groups of 18 Newton (SD=14.8) with a power of 90% and a two-sided significance level of 5%; with equal allocation to two arms (10 vonlays in each group).

Group I: Ten vonlay samples (n=10) fabricated of IPS e.max CAD

Group R: Ten vonlay samples (n=10) fabricated of Rosetta®SM CAD.

Master die construction:

1. Teeth selection:

Naturally Extracted maxillary premolar free of dental caries or restoration was chosen. Remaining soft tissue was removed by ultrasonic scaler and the tooth was cleaned. This tooth was extracted due to orthodontic purposes.

2. Tooth disinfecting and storage:

The selected tooth was disinfected for 15 minutes by immersion in 5 % sodium hypochlorite solution at room temperature, followed by cleaning using a low-power ultrasonic scaler and under a significant volume of water coolant to prevent the creation of any micro-cracks. Prior to the study the tooth were kept hydrated in the saline solution at the room temperature.

3. Tooth preparation:

Manufacture of a silicone index to determine the volume of occlusal reduction used prior to the preparation of the natural tooth using a scoop of putty mixed in compliance with the manufacturer's instructions with universal activator for 1:15 min until an entirely homogeneous colour has been achieved. Then adapted to the tooth surface and left for 4:30 mins till full setting according to manufacturer instructions.

Then splitting of the putty index into two halves was done by using lancet blade no. 15 Fig. (1).

Figure (1) Checking axial reduction and occlusal clearance using putty index

Following ceramic MOD inlay restoration preparation guidelines, the preparation was done with a tapered flat end diamond bur where occlusal reduction by 1.5 mm of non-functional cusp and occlusal reduction by 2 mm of the functional cusp was prepared Fig. (2).

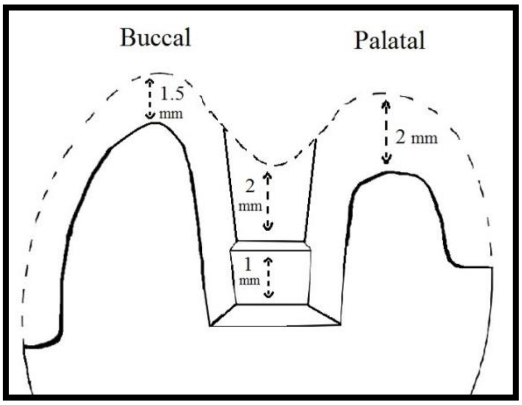

Figure (2) Diagram for vonlay preparation

Depth of occlusal box was extended by 2 mm from cusp tip to the pulpal floor, 1 mm depth from the pulpal floor to the gingival seat with 12º divergence angle with conical flat end diamond bur *ending with the isthmus portion measuring 1/3 the buccolingual width.

Duplication of the prepared tooth:

Producing mould for duplication:

Silicon duplicating material was used to make a silicon mould for the epoxy resin dies construction. The natural tooth was then placed in a 20 mm diameter plastic cylindrical jar.

Following the manufacturer's recommendations, equivalent amounts of the base and the catalyst of the duplicating material were mixed for 5 min, and then poured into a plastic container under vibration to remove any trapped air. It was left to set the silicone mould for 30 minutes based on the manufacturer's instructions. The natural tooth was finally removed.

Construction of epoxy dies:

Base and catalyst in a ratio of 1:1 of the epoxy resin material were mixed at the rate of 200/min according to manufacturer instructions.

The mix was poured into the silicon mould under vibration to eliminate any entrapment of air and then left for curing at room temperature for 24 hours; after setting, they were removed from their mould.

The duplicating dies were designed with a large base of epoxy resin to help hold each die during cementing and support it during cyclic loading and fracture resistance testing. Fig. (3)

Figure (3) epoxy die proximal view

N.B. to standardize preparation for all samples; A silicon index fabricated before preparation to check occlusal clearance along with a periodontal probe (Figure 7 A & B), also fabrication of metal block using lost wax technique was utilized to check in the MOD inlay preparation

Optical impression of the prepared acrylic tooth:

Each die was digitally scanned via optical scanning using the Medit i500 scanner.*

The accuracy of the scan was visually checked from all views to ensure complete digitization of the epoxy die without any defects. as shown in Fig. (4).

Figure (4) Digital die after scanning "proximal view"

Computer aided design of the restoration:

The margins for digital die have been identified and drawn using Exocad Software. To start designing the restoration, the path of insertion was identified, and then milled material was selected from the software library which was Rosetta ® SM CAD and IPS e.max CAD blocks.

Milling of the restorations:

Milling was accomplished using Sirona MCX5 milling machine (Fig. 4) using blocks of IPS e.max CAD and Rosetta SM CAD: 10 blocks of IPS e.max CAD with block size C14 and 10 Rosetta sm CAD blocks with block size PC14 were used.

Each block was inserted into the spindle of the work piece and tightened, together with the block holder.

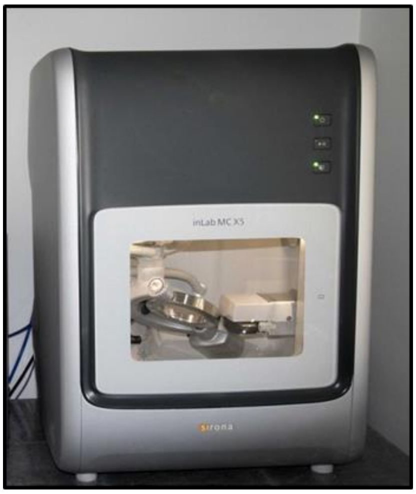

Figure (5) MCX5 milling machine

Crystallization & Glazing:

After milling, the IPS e.max and the Rosetta ceramic vonlays are in their pre-crystallization form, where they both have a blue violet color. To complete crystallization process, they were placed in a ceramic furnace to achieve their final strength and esthetic properties.

Vonlays were held in place by an object fix material and firing pins then fired on the supplying firing tray corresponding to the manufacturer's instructions.

For the Rosetta®SM samples; the vonlays were first pre-heated at 400ºC for 4 minutes and the heating temperature was then raised at 60ºC/min rate until it reached 840ºC and was maintained for 10 minutes, according to manufacturer instructions.

For the IPS e.max vonlays; they were firstly pre-dried at 403ºC for 6 minutes and the heating temperature was then raised at a rate of 90ºC/min until it reached 820ºC and was held for 10 minutes, then the temperature was then raised at a rate of 30ºC/min until reaching 840ºC and was held for 7 minutes. After firing, the samples were left to cool at the room temperature.

Cementation procedures:

Surface treatment of all vonlays fitting surfaces using 9.5 % hydrofluoric acid etchant for 20 seconds and then rinsing with a water spray. Then rinsing the acid for 20 seconds under running water.

Then the internal surface was dried with oil free air spray. Then use fine brush to apply a single layer of silane coupling agent to the fitting surface and leave it for 60 seconds, then finally air drying.

Specially constructed cementing device:

A custom designed cementation device that was made from metal to aid in load application during cementation procedure also applies standard cementation force during setting of cement.

It was composed of three parts (A - C):

A: Fixed base section with a rectangular shape (10 cm length of 1.2 cm height and 2.3 cm width). This is where the acrylic resin block will rest.

B: Upper movable section has a rectangular shape (10 cm length of 1.2 cm height and 2.3 cm width). This portion is bound to the base portion by two metallic rods surrounded by spring wire, which controls the compressibility of the upper portion and is secured by tightening plastic caps. It is also lined with a rubber layer to prevent friction from causing damage to the specimen during cementation.

C: Weight bearing portion: T-shaped with its vertical end rest on the upper movable part while the flat end used for weight bearing. The standard load is applied through universal testing machine.

The epoxy die was then placed over the center of the base portion of the cementing device as shown in Fig. (6).

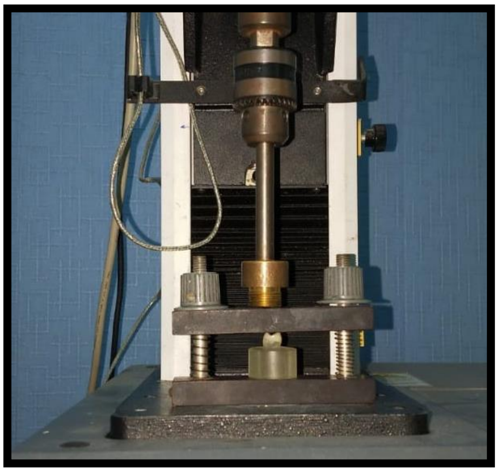

Figure (6) standard load application during cementation

Testing methods:

Cyclic loading:

To mimic intra oral conditions, mechanical aging via cyclic loading was performed using a programmable logic-controlled equipment; the newly developed four stations multimodal ROBOTA chewing simulator integrated with cyclic protocol operated on servo-motor with special parameters.

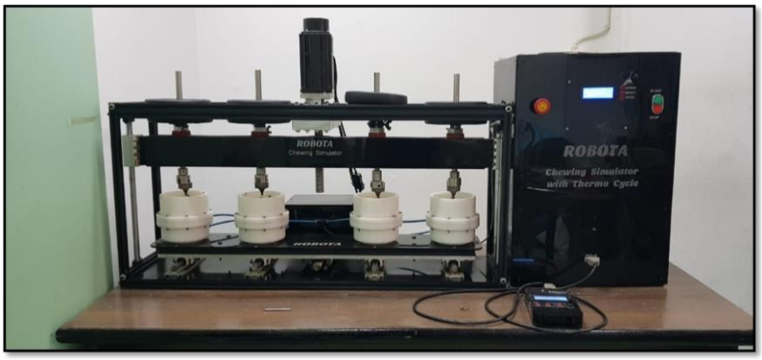

Figure (7) cyclic loading device

Fracture resistance:

After the cyclic loading tests, the samples were subjected to compressive load until fracture. All samples were individually mounted on a computer controlled materials testing machine with a load cell of 5 kN and data were recorded using computer software. Samples were secured to the lower fixed compartment of testing machine by tightening screws. Fracture test was done by compressive mode of load applied occlusally using a metallic rod with round tip (3.8 mm diameter) attached to the upper movable compartment of testing machine traveling at cross-head speed of 1mm/min with tin foil sheet in-between to achieve homogenous stress distribution and minimization of the transmission of local force peaks.

Microscopic examination:

2.11.3.1 Stereomicroscope

To assess the modes of failure, the samples were examined under a stereomicroscope. The failure modes were divided into two categories: ceramic fracture "repairable" or combined ceramic and tooth fracture "irrepairable or catastrophic". **(1)**

Scanning electron microscope (SEM):

Surface images of the fractured surface for each vonlay were obtained using Quanta FEG 250 scanning electron microscope. Fractured samples were mounted onto SEM stubs. Applied SEM conditions were: a 11.5 mm working distance, with in-lens detector with an excitation voltage of 10 kV.

Results.

1.1. Fracture resistance statistical analysis

Descriptive statistics of fracture resistance (N) showing mean, standard deviation (SD), minimum, maximum and 95% confidence intervals (low and high) values for both groups after thermo-mechanical aging.

The mean values ± SDs values for e.max group were (502.39 ±102.89 N) with minimum value (338.16 N) and maximum value (721.29 N). The mean values ± SDs values for Rosetta group were (468.76 ± 67.54 N) with the minimum value (367.11 N) and the maximum value (648.48 N) as shown in Fig. (8).

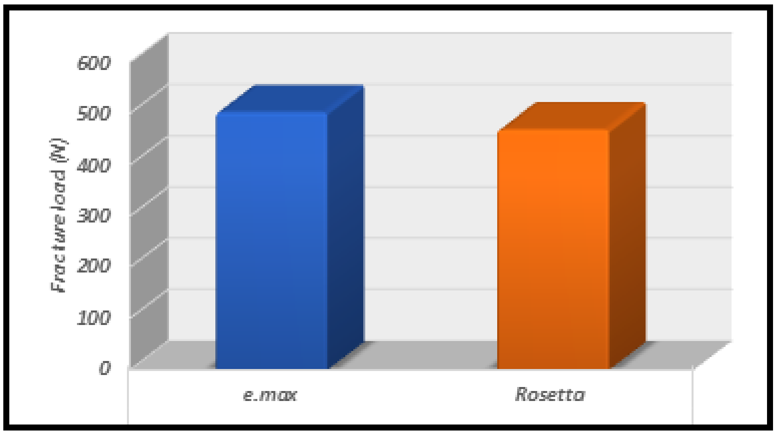

Figure (8) Column chart of fracture resistance mean values of both groups after mechanical aging

2. Failure mode analysis:

Specimens were examined microscopically after loading by one investigator and the extent of fracture was determined

The failures were divided into "repairable failure" and "irrepairable or catastrophic failure". The failure mode was regarded repairable if it involved the restoration only or part from the cusps. And it was considered as irrepairable or catastrophic when the fracture line split the tooth "representing on dies" into two parts at the level of the floor of the pulp chamber. **(2)**

It was found that. 60% of e.max group exhibited repairable failure while 40% of specimens showed catastrophic failure.

In Rosetta group, 90% of the specimens exhibited repairable failure. Only 10% of displayed catastrophic failure). as shown in Fig. (9).

Figure (9) Representative image showing catastrophic failure in Rosetta group

The difference in failure mode patterns between experimental groups was statistically significant as indicated by chi square-test (chi = 22.4, p value = <.0001< 0.05) as shown in Fig. (10).

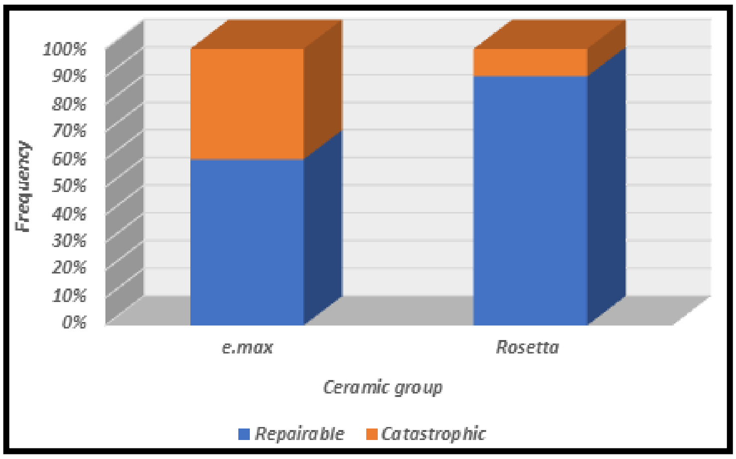

Figure (10) Column chart showing frequent distribution of fracture pattern for both groups

3. Scanning electron microscope examination

Similar crystalline structural patterns were revealed in both of SEM images of (Rosetta SM CAD) and (IPS e. max CAD) vonlays. The spindle-shaped crystals were distributed uniformly in an interlocking network, which is common for the two materials.

Except for Rosetta, the SEM image revealed crystals with smaller and more densely packed crystalline structures, which can prevent propagation of cracks and thus increase mechanical strength as shown in Fig. (11).

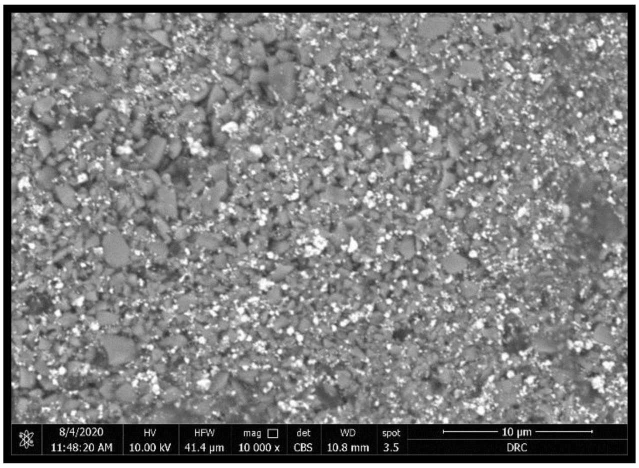

Figure (11) (FE - SEM) micrographs of fractured part of Rosetta CAD, (x10000), shows that crystals densely packed than e.max CAD

Discussion.

All-ceramic materials are now extensively used in fixed prosthodontics. Even though metal ceramic restorations continue to be regarded as the gold standard, the popularity of all ceramic materials is increasing day by day. Lithium disilicate is a glass ceramic material with superior esthetic and mechanical characteristics. The material is extensively used for esthetic restoration of anterior teeth. The improved mechanical properties of this glass ceramic material have extended its clinical indications. The ability to fabricate the restoration using CAD/CAM technology makes it the material of the modern-day. However, a better knowledge of the material is necessary for its effective and successful clinical use **(11).**

Ceramic materials' mechanical performance is influenced by their compositional and microstructural properties, and also the presence of impurity phases and defects. As a result, there has been continuous process of developing CAD/CAM materials with improved mechanical properties through composition modification and structural flaw reduction **(15).** Also ceramics' crystalline structure determines their mechanical and morphological properties **(16).** On the other hand, The higher the glassy phase, the better the translucency of ceramics; though, it weakens the structure by lowering resistance to crack propagation **(3).** Also one of the most important factors influencing the survival of ceramic restorations, including inlays and onlays, is the fracture resistance **(18).**

With the introduction of high-strength materials such as lithium disilicate, as well as manufacturing technology such as CAD/CAM and heat pressing, Dentists can now make highly esthetic, high-strength restorations that merge perfectly with the natural dentition while still resisting posterior occlusal forces. As a result, creative ways of delivering minimally invasive dentistry have developed. Such a concept is called "vonlay" which is a combined restoration as explained in this thesis. Vonlays could be used as an alternate to complete coverage crowns to restore defective posterior teeth especially premolars **(13).** They are made from monolithic ceramic structure which combines onlay and buccal veneer.

Partial coverage restoration "vonlay" was chosen as less -aggressive tooth preparation is more predictable, as it is less traumatizing, the more we prevent tooth tissue loss, the less postoperative discomfort will be experienced by the patient. In addition, minimally invasive techniques not only ensure biological and biomechanical requirements but also improve esthetic results substantially. These procedures are becoming simpler as conservative tooth preparation and restorative procedures are now possible thanks to the development of both ceramic technologies, CAD/CAM systems in particular, and bonding materials **(4).**

Lithium disilicate was chosen in this study as they have enhanced bonding properties that have made it possible to produce greatly esthetic restorations with high biocompatibility, and optimal mechanical properties, which can be indicated, as a consequence, safely even for posterior teeth **(4).**

The CAD/CAM blocks of lithium disilicate ceramic were exclusively available from a single company (Ivoclar Vivadent, Germany). Another blocks of lithium disilicate ceramic (Rosetta SM, Hass, Gangneung, Korea) has been made available **(9).** And that was the reason for selection of Rosetta SM CAD blocks for comparing it with IPS e.max blocks.

With the advent in digital dentistry and computer-aided designing and manufacturing techniques (CAD/CAM), IPS e.max CAD was released in 2006 as a lithium disilicate reinforced glass ceramic that was specially designed for CAD/CAM usage. IPS e max CAD was also selected for its aesthetic qualities, ease of use and outstanding strength. Flexural resistance of IPS e.max CAD has been shown to be greater than that of other leucite reinforced dental ceramics. A research (Lien et al., 2015) on the development of mechanical properties at different temperatures during the heat process discovered that the heating schedule could significantly modify the macromechanical properties. Another research **(7)** concluded that when comparing IPS e.max CAD to other viable CAD/CAM ceramics, mechanical properties are determined by the compositional structure of the material rather than its chemical formulation **(17).**

Blocks for IPS e.max CAD are composed of 0.2-um to l-um lithium metasilicate crystals, with around 40% crystals by volume. The color of the block is bluish violet, which corresponds to the widely used "Blue Block" definition. Since the block is partly crystallized "soft, " it can be milled easily without risking excessive wear to diamond bur or material damage. Following milling, the restoration must go through a firing process of two stages under vacuum in a porcelain oven for (20 to 25 minutes) to complete the crystallization of the lithium disilicate. This also transforms the precrystallized block's blue colour to the desired tooth colour, resulting in a glass ceramic material with a grain size of approximately 1.5 um and a 70 percent crystal by volume embedded in a glassy matrix **(6).**

Selection of epoxy resin for die fabrication to provide standardized preparations and for not affecting the outcome of this study, as according to studies **(10)** the Young's modulus of dies made from these substances is about 12.9 GPA, which is comparable to human dentin. Furthermore, epoxy resin is compatible with the majority of impression materials and has shown superior reproduction of details, abrasion resistance, and transverse strength compared to gypsum-based materials **(14).** Moreover, Epoxy resin outperformed other materials in terms of dimensional accuracy, reproduction of surface details, and transverse strength, also it is the closest material to accurate die material standards **(8).**

In vitro study for evaluating possible new materials or techniques that will be tested in vivo is a significant aspect of dentistry. In vitro testing has also the advantage of allowing researchers to conduct single-variable experimentations under controlled circumstances **(12).** Also preclinical in vitro studies for dental materials are critical in assessing mechanical properties and material compatibility in the mouth **(5).**

In addition to **Tavares et al., 2020**[(16)] who stated that there were no major difference between the two CAD-CAM lithium disilicate based ceramics studied since they had identical crystalline structures with comparable intensities, as well as similar bond strength and total porosity. At the pre-crystallized and crystallized phases, XRD results indicated that the key crystalline composition for Rosetta SM were identical to those of IPS e.max.

The SEM “scanning electron microscope” images of the two tested ceramic materials in this study were similar. The spindle shaped crystals were uniformly distributed in an interlocking network, which is typical of the two ceramic materials.

Rosetta SM has crystalline structure in which spindle-shaped crystals were densely packed. This arrangement and orientation of crystals in the glassy matrix can prevent propagation of cracks and subsequently improve mechanical strength and resistance to fracture. Even if cracks did form, they would be locked within the crystals in an indirect way, effectively stopping further propagation. It was also proved in the results of the statistical analysis which shows 90% repairable failures of Rosetta CAD vonlays compared to 60 % repairable failures of E.max CAD vonlays **(9).**

According to the results of this in vitro study, the tested two ceramic materials showed similar fracture resistance, and nearly similar molecular composition. Therefore, either of these lithium disilicate based ceramics may be used in the selection of glass ceramic CAD/CAM restorations. As a result, this will increase the available alternatives to the dental practitioners and laboratory technicians.

This in vitro study has limitations as regards to representing real clinical conditions such as simulation of periodontal ligament (PDL) and oral environment. A further limitation was that all tests were not carried out on natural teeth, but on epoxy resin dies which might have lacked the simulation of the clinical situation.

CONCLUSION.

Within the limitations of this current study, the following conclusions were obtained:

- (Rosetta SM CAD) and (IPS e.max CAD) restorations have clinically acceptable fracture resistance values and could be used safely in the premolar area.
- Vonlay preparation is regarded as a credible and conservative partial coverage restoration that can be used in the premolar area.
- Vonlays manufactured from Rosetta®SM CAD blocks demonstrated better repairable failure modes compared to that of IPS e.max CAD blocks.

RECOMMENDATION.

Depending on the findings of this study, additional research into the material's mechanical and esthetic properties should be performed. In vitro studies on natural teeth involving different loading techniques before and after cyclic loading are also recommended. Clinical studies should also be carried out to assess the material's durability and performance in oral environment.

References.

1. Andrade, J. P., Stona, D., Bittencourt, H. R., Borges, G. A., Burnett, L. H., & Spohr, A. M.: (2018): Effect of different computer-aided design/computer-aided manufacturing (CAD/CAM) materials and thicknesses on the fracture resistance of occlusal veneers: Oper. Dent., 43(5), 539–548. https://doi.org/10.2341/17-131-L.

2. Babu, P. J., Alla, R. K., Alluri, V. R., & Datla, S. R.: (2015): Dental Ceramics: Part I – An Overview of Composition, Structure and Properties: March. https://doi.org/10.12691/materials-3-1-3
3. Boukhris, H., Touffeha, G., Nouha, M., Karoui, L., & Hajjami, H.: (2018): Veneerlays : A suitable Conservative Approach for Restoring Posterior Teeth: 2(5), 1–9.
4. Choi, J. W., Kim, S. Y., Bae, J. H., Bae, E. Bin, & Huh, J. B.: (2017): In vitro study of the fracture resistance of monolithic lithium disilicate, monolithic zirconia, and lithium disilicate pressed on zirconia for three-unit fixed dental prostheses: J. Adv. Prosthodont., 9(4), 244–251. https://doi.org/10.4047/jap.2017.9.4.244.
5. Fasbinder, D. J.: (2010): Materials for chairside CAD/CAM restorations.: Compend. Contin. Educ. Dent., 31(9).
6. Goujat, A., Abouelleil, H., Colon, P., Jeannin, C., Pradelle, N., Seux, D., & Grosgogeat, B.: (2018): Mechanical properties and internal fit of 4 CAD-CAM block materials: J. Prosthet. Dent., 119(3), 384–389. https://doi.org/10.1016/j.prosdent.2017.03.001.
7. Gujjarlapudi, M. C., Reddy, S. V., Madineni, P. K., Kiran, K., & Ealla, R.: (2014): Comparative Evaluation of Few Physical Properties of Epoxy Resin, Resin-Modified Gypsum and Conventional Type IV Gypsum Die Materials: An in vitro Study: January 2012.
8. Kang, S.-H., Chang, J., & Son, H.-H.: (2013): Flexural strength and microstructure of two lithium disilicate glass ceramics for CAD/CAM restoration in the dental clinic: Restor. Dent. Endod., 38(3), 134. https://doi.org/10.5395/rde.2013.38.3.134.
9. Kiran, Deepak, T. N.: (2019): In vitro evaluation of fracture resistance and cyclic fatigue resistance of computer‑aided design‑on and hand‑layered zirconia crowns following cementation on epoxy dies: J. Indian Prosthodont. Soc., 19(1), 88–92. https://doi.org/10.4103/jips.jips.
10. Kurian, B. P., Johns, M., & George, J.: (2018): Lithium disilicate ceramic – An overview: J. Prosthet. Implant Dent., 1(2), 116–122.
11. Mariano, C., & Jr, F.: (2012): Guidelines for Reporting Pre-clinical In Vitro Studies on Dental Materials: J. Evid. Based. Dent. Pract., 12(4), 182–189. https://doi.org/10.1016/j.jebdp.2012.10.001.
12. McLaren, E. F. J. G. R.: (2015): Vonlays: 36(4).
13. Prisco, R., Cozzolino, G., & Vigolo, P.: (2008): Dimensional Accuracy of an Epoxy Die Material Using Different Polymerization Methods: 1–6. https://doi.org/10.1111/j.1532-849X.2008.00399.x.
14. Shahmoradi, M., Wan, B., Zhang, Z., Wilson, T., Swain, M., & Li, Q.: (2020): Monolithic crowns fracture analysis: The effect of material properties, cusp angle and crown thickness: Dent. Mater., 36(8), 1038–1051. https://doi.org/10.1016/j.dental.2020.04.022.
15. Tavares, L. D. N., Zancopé, K., Silva, A. C. A., Raposo, L. H. A., Soares, C. J., & Neves, F. D. Das: (2020): Microstructural and mechanical analysis of two CAD-CAM lithium disilicate glass-reinforced ceramics: Braz. Oral Res., 34, e004. https://doi.org/10.1590/1807-3107bor-2020.vol34.0004.

16. Willard, A., & Chu, T. G.: (2018): ScienceDirect The science and application of IPS e. Max dental ceramic: Kaohsiung J. Med. Sci., 1–5. https://doi.org/10.1016/j.kjms.2018.01.012.
17. Yoon, H. I., Sohn, P. J., Jin, S., Elani, H., & Lee, S. J.: (2019): Fracture Resistance of CAD/CAM-Fabricated Lithium Disilicate MOD Inlays and Onlays with Various Cavity Preparation Designs: J. Prosthodont., 28(2), e524–e529. https://doi.org/10.1111/jopr.12787.