

University of Mosul
College of Dentistry



**Impact of Simulated Gastric Acid on Microhardness,
Microleakage, and Tensile Bond Strength of Class II Inlay
Indirect Restorations (An in vitro study)**

A Thesis Submitted by:

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To

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ABSTRACT

Background: Gastroesophageal reflux disease (GERD) is a common medical illness that unintentionally causes gastric acid to move into the mouth. This disorder substantially influences a large section of the world's population, with prevalence rates in adults varying from 21% to 56% across different nations. Furthermore, it has a dramatic effect on oral health.

Aim: This study aimed to investigate the effect of using Simulated Gastric Acid Solution (SGAS) on the microhardness, microleakage, and tensile bond strength of four distinct restorative materials. By doing so, we sought to provide valuable insights into the durability and resilience of these materials in the face of gastric acid exposure.

Materials and Methods: For the microhardness test, a total of forty square plates measuring 10 x 10 mm and 2 mm in thickness were acquired from the following four restorative materials: IPS e.max Press, multilayer high-strength cubic zirconia, Filtek Bulk Fill Posterior Restorative, and EverX Posterior Fibre Reinforced Dental Composite, after being submerged in artificial saliva for 36 hours. The identical samples were then exposed to an SGAS for 18 hours and subsequently for an additional 18 hours. Then, the samples underwent the Vickers microhardness test. For tensile bond strength and microleakage test, eighty sound maxillary first premolars were included in this study. All teeth underwent the creation of separated standardised MO and DO Class II inlay cavities (4mm width x 4mm depth x 2mm length) using a high-speed handpiece mounted on a modified dental surveyor. The Teeth were randomly assigned into four groups (n = 20) according to the type of restorative material used. The first group was restored using IPS e.max Press. The second group was restored with multilayer high-strength cubic zirconia. The third group was restored with Filtek Bulk Fill Posterior Restorative, and the fourth group was restored with EverX Posterior Fibre Reinforced Dental Composite. The samples in the four main categories were additionally subdivided into two subgroups (n = 10) based on their



immersion for 93 hours in artificial saliva and an SGAS cycle. Following the finalisation of the 180 cycles, the samples underwent a tensile bond strength assessment using a universal testing apparatus. For the microleakage test, the samples were immersed in a 50% silver nitrate solution for 24 hours and thereafter treated with a developer solution for 8 hours. These samples were encapsulated in transparent epoxy resin and sliced in a buccolingual orientation at 0.5 mm. A stereomicroscope was used to examine the slices at a 10X magnification with a graded lens. SPSS software was utilised to conduct a statistical analysis of the gathered data.

Results: The impact of SGAS was evident on all tested materials. For microhardness, a significant difference was observed between groups after immersion in SGAS ($p < 0.000$). The zirconia group exhibited the highest surface microhardness, while the fibre-reinforced composite group had the lowest. A significant difference in tensile bond strength was observed between groups after immersion in SGAS ($p < 0.000$). The lithium disilicate group demonstrated the greatest tensile bond strength, whereas the cubeX zirconia group exhibited the least. Additionally, a significantly different disparity in microleakage was observed after immersion in SGAS ($p < 0.05$).


Conclusion: The SGAS substantially reduces the surface microhardness and compromises the surface integrity of the tested materials. Additionally, all samples showed a notable decline in tensile bond strength after exposure to an SGAS. Also, the SGAS increases the microleakage of the tested materials.

Impact of Simulated Gastric Acid on Microhardness, Microleakage, and Tensile Bond Strength of Class II Inlay Indirect Restorations

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HIGHLIGHTS	GRAPHICAL ABSTRACT
<ul style="list-style-type: none"> • A significant difference was observed in tensile bond strength between groups after immersion in (SGAS) ($p < 0.000$). • For microhardness, a significant difference was observed between groups at 18 and 36 hours after immersion in (SGAS) ($p < 0.000$). • A significantly different disparity in microleakage was observed after immersion in (SGAS) ($p < 0.05$). • The lithium disilicate group demonstrated the greatest tensile bond strength, whereas the cubeX zirconia group exhibited the least. 	
<p>Keywords:</p> <p>Simulated gastric acid. GERD. Bulimia nervosa. Tensile bond strength. Microhardness. Microleakage. IPS Emax press. Zirconia. Composite.</p>	<p>ABSTRACT</p> <p>Gastroesophageal reflux disease (GERD) is a common medical illness that unintentionally results in the movement of gastric acid into the mouth. This disorder substantially influences a large section of the world's population, with prevalence rates in adults varying from 21% to 56% across different nations. Furthermore, it has a dramatic effect on oral health.</p> <p>Materials and Methods: for tensile bond strength and microleakage test, eighty sound maxillary first premolars were included in this study. The Teeth were randomly assigned into four groups ($n=20$) according to the restorative materials. The first group was rehabilitated using Filtek Bulk Fill Posterior Restoration(3M™). The second group was restored with EverX Posterior Fiber Reinforced Dental Composite (GC™). The third group was restored with multilayer high-strength cubeX zirconia (Dental Direkt™), and the fourth group was restored with IPS e-max press (Ivoclar/Vivadent™). The samples in the four main categories were additionally subdivided into two subgroups ($n=10$) based on their immersion for 93 hours in either artificial saliva or simulated gastric acid solution cycle (SGAS). Subsequent to the 180 cycles being finalized, the samples underwent a tensile bond strength assessment utilizing a universal testing apparatus. For the microleakage test, the samples were immersed in a 50% silver nitrate solution for 24 h and thereafter treated with a developer solution for 8 h. These samples were encapsulated in transparent epoxy resin and sliced in a buccolingual orientation at 0.5 mm. A stereomicroscope examined the slices at a zoom level of 10X. For the microhardness test a total of forty square plates measuring 10 X 10 mm and 2 mm in thickness were acquired of the following four restorative materials: Filtek Bulk Fill Posterior Restorative(3M™), EverX Posterior Fiber Reinforced Dental Composite (GC™), multilayer high-strength cubic zirconia (Dental Direkt™), and IPS e-max press (Ivoclar/Vivadent™). After being submerged in artificial saliva for 36 hours, the specimens underwent the Vickers microhardness test. The identical specimens were also exposed to (SGAS) for 18 and again for an extra 18 hours. SPSS software was utilized to conduct a statistical analysis of the gathered data. Results: The impact of simulated gastric acid was evident on all tested materials, with a significant difference observed in tensile bond strength between groups after immersion in (SGAS) ($p < 0.000$). The lithium disilicate group demonstrated the greatest tensile bond strength, whereas the cubeX zirconia group exhibited the least. Also, A significantly different disparity in microleakage was observed after immersion in (SGAS) ($p < 0.05$). For microhardness, a significant difference was observed between groups at 18 and 36 hours after immersion in (SGAS) ($p < 0.000$). The zirconia group exhibited the highest surface microhardness, while the fibre-reinforced composite group had the lowest. Conclusion: The simulated gastric acid significantly reduces the surface microhardness and compromises the surface integrity of tested materials. Notably, all samples exhibited a notable decline in tensile bond strength following exposure to simulated gastric acid. Also, the simulated gastric acid increases the microleakage of tested materials.</p> <p style="text-align: center;">2025 M.Sc. Thesis @Univ. of Mosul, College of Dent., Cons. Dent. Dept. (https://www.uomosul.edu.iq/).</p>



جامعة الموصل
كلية طب الاسنان

تأثير حمض المعدة المُحاكي على الصلابة الدقيقة والتسرب الدقيق وقوة الترابط بالشد
في الترميمات غير المباشرة من الفئة الثانية

رسالة تقدم بها

ياسر خالص محيسن

الى مجلس كلية طب الاسنان/ جامعة الموصل

كجزء من متطلبات نيل شهادة الماجستير في علوم علاج الاسنان التحفظي

بإشراف

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المستخلص

الخلفية: مرض الارتجاع المعدي المريئي هو مرض طبي شائع يؤدي بشكل غير مقصود إلى انتقال حمض المعدة إلى الفم. يؤثر هذا الاضطراب بشكل كبير على جزء كبير من سكان العالم، حيث تتراوح معدلات انتشاره بين البالغين من ٢١٪ إلى ٥٦٪ في مختلف الدول. علاوة على ذلك، له تأثير كبير على صحة الفم.

الأهداف من الدراسة: هدفت هذه الدراسة إلى دراسة تأثير استخدام محلول محاكاة حمض المعدة على الصلابة الدقيقة، والتسرب الدقيق، وقوة الالتصاق الشدي لأربع مواد ترميمية مميزة. سعينا من خلال ذلك إلى تقديم رؤى قيمة حول متانة هذه المواد ومرونتها في مواجهة التعرض لحمض المعدة.

المواد والطرق: لاختبار قوة الالتصاق بالشد والتسرب الدقيق، تم تضمين ثمانين ضرساً أولياً سليماً في هذه الدراسة؛ تم توزيع الأسنان عشوائياً في أربع مجموعات (كل مجموعة مكونة من ٢٠ عينة) وفقاً لمواد الترميم. تم ترميم المجموعة الأولى باستخدام (Filtek Bulk Fill Posterior Restorative) وتم ترميم المجموعة الثانية باستخدام (EverX Posterior Fiber Reinforced Dental Composite) تم ترميم المجموعة الثالثة باستخدام (cubeX zirconia)، وتم ترميم المجموعة الرابعة باستخدام (IPS e-max press) تم تصنيف العينات في الفئات الأربع الرئيسية أيضاً إلى مجموعتين فرعيتين (كل مجموعة مكونة من ١٠ عينات) بناءً على غمرها لمدة ٩٣ ساعة إما في اللعاب الاصطناعي أو محلول حمض المعدة المحاكي.

لاختبار صلابة المجهر تم الحصول على ما مجموعه أربعين لوحة مربعة بقياس ١٠ × ١٠ مم وسمك ٢ مم من مواد الترميم الأربعة التالية: (Filtek Bulk Fill Posterior Restorative)، (EverX Posterior Fiber Reinforced Dental Composite)، (cubeX zirconia) و (IPS e-max press). بعد غمرها في اللعاب الاصطناعي لمدة ٣٦ ساعة، خضعت العينات لاختبار صلابة المجهر Vickers. كما تعرضت العينات المتطابقة لحمض الهيدروكلوريك (٠,٠٦ مolar حمض الهيدروكلوريك؛ درجة حموضة ١,٢) لمدة ١٨ ساعة ثم مرة أخرى لمدة ١٨ ساعة إضافية. وتم استخدام برنامج SPSS لإجراء تحليل إحصائي للبيانات المجمعة.

النتائج: كان تأثير حمض المعدة المحاكي واضحاً على جميع المواد المختبرة، مع ملاحظة وجود فرق كبير في قوة الترابط بالشد بين المجموعات بعد الغمر في حمض المعدة المحاكي ($p < 0.000$). أظهرت مجموعة ثنائي سيليكات الليثيوم أكبر قوة ترابط بالشد، في حين أظهرت مجموعة مكعب الزركونيا أقل قوة. كما كان هناك فرق كبير إحصائياً في التسرب الدقيق بعد الغمر في حمض المعدة المحاكي ($p < 0.05$). بالنسبة للصلابة الدقيقة، لوحظ فرق كبير للغاية بين المجموعات بعد ١٨ و ٣٦

ساعة من الغمر في حمض المعدة المحاكي ($p < 0.000$). أظهرت مجموعة الزركونيا أعلى صلابة سطحية دقيقة، في حين أظهرت مجموعة المواد المركبة المقواة بالألياف أدنى صلابة. الاستنتاج: يقلل حمض المعدة المحاكي، بغض النظر عن نوعه، بشكل كبير من صلابة السطح ويعرض سلامة سطح المواد المختبرة. والجدير بالذكر أن جميع العينات أظهرت انخفاضاً ملحوظاً في قوة الالتصاق بالشد بعد التعرض لحمض المعدة المحاكي. ومع ذلك، اختلف مدى انخفاض الشد في جميع المجموعات المختبرة. كما يزيد حمض المعدة المحاكي من التسرب المجهري للمواد المختبرة.