The difference in tensile bond strength of an adhesive cement resin to an etched and perforated resin-bonded bridges

Perbedaan *tensile bond strength* dari resin semen adesif dengan gigi tiruan jembatan etsa dan perforansi

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ABSTRACT
Several improvements to the metal cast framework have been suggested since resin-bonded fixed partial dentures was introduced. Essentially, there are two types of retainer designs based on retention namely macromechanical retention with a perforated retainer commonly referred to as Rochette bridge and micromechanical retention derived from the etched metal cast retainer called as Maryland bridge. This study is aimed to compare the tensile bond strength of an adhesive cement resin to an etch and perforated resin-bonded bridge. Using experimental laboratory design, the sample tested consisted of 10 plates Ni-Cr alloy, 13 mm in diameter and 1 mm in thickness were divided into two treatment groups; five plates were perforated, and five plates were etched using Met-Etch Gel. Tensile strength was determined using an Ametek Llyod Instrument. The result showed that the strength of resin adhesive cement on the metal surface of alloy Ni-Cr used etch higher than perforated. Statistical analysis used student t-test recorded t-test 2.75 and p-value 0.0125, so it said significant differences because p-value was smaller than 0.05. This study showed that etch cast metal retainers were more retentive than perforated design.
Keywords: resin-bonded bridges, the adhesive strength of resin adhesive cement, etch, perforated, alloy Ni-Cr

ABSTRAK
Beberapa perkembangan perlakuan terhadap gigi tiruan jembatan (GTJ) logam adesif telah disarankan sejak GTJ adesif mulai diperkenalkan. Pada dasarnya terdapat dua jenis desain retainer berdasarkan metode retensi, yaitu retensi mekanis makro dengan pemberian beberapa lubang yang dikenal sebagai GTJ Rochette, dan retensi mekanis mikro dengan pemberian etsa yang biasa disebut GTJ Maryland. Penelitian ini dimaksudkan untuk mengetahui perbedaan kekuatan lekat semen resin pada sayap logam GTJ adesif yang dietsa dengan yang diberi beberapa lubang; dilakukan dengan desain eksperimental laboratoris. Sampel lempeng logam Ni-Cr berdiameter 13 mm setebal 1 mm yang dibagi menjadi dua kelompok perlakuan; lima diberikan beberapa lubang dan lima buah dietsa dengan menggunakan gel *Met-Etch*. Data kuat tarik yang diukur memakai *Ametek Llyod Instrument* adalah kekuatan lekat semen resin pada permukan logam alloy Ni-Cr dengan etsa lebih tinggi dibanding yang diberikan beberapa lubang. Analisis statistik dengan uji-t mendapatkan nilai-t hitung 2,75 dan *p-value* 0,125, sehingga dikatakan hasilnya signifikan karena *p-value* lebih kecil dari 0,5. Disimpulkan bahwa logam yang diberi etsa lebih retentif hasilnya dibandingkan logam yang diberi beberapa lubang.
Kata kunci: gigi tiruan jembatan adesif, kekuatan lekat semen resin adesif, etsa, beberapa lubang, aloi Ni-Cr
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INTRODUCTION

A resin-bonded bridge or adhesive bridge is a fixed denture that is quite popular today since Rochette in 1973 introduced a technique for splinting the mandibular anterior teeth using a metal casting given several holes.[1-5] The results of Rochette's work, when applied to fixed prostheses, create an alternative to metal-ceramic fixed prostheses with minimal reduction of abutment teeth structure, also known as the Rochette bridge.[1,3]

The failures of the Rochette bridge is caused by its retention is limited to the perforated area and is not consistent on the entire surface of the framework.[3,5] A method was developed to electrolytically etch a nonprecious metal surface on a bridge without making several holes, to produce a microscopically rough surface, so micromechanical bonding with the adhesive occurs.[1,3–5] Electrolytic etching provides four times greater bond strength than the Rochette bridge.[4] This electrolytically etched bridge is called the Maryland bridge because the development of this type of bridge was carried out at the University of Maryland with the same aesthetic results as the Rochette bridge but with better retention.[3,6]

Electrolytic etching has several drawbacks; it requires special laboratory equipment. The etching quality depends on various factors such as the type of alloy, type of acid used, acid concentration, etching time, and electrical density. Due to these limitations, several alternative techniques for treating metal surfaces have been developed.[4,5,7] Starting from chemical etching with various types of acids, the use of the "lost salt" technique (the Virginia bridge) with NaCl salt and the use of nylon mesh to strengthen the bonding of metal surfaces..[5]

The etching method was initially developed for nickel-chromium alloys (Ni-Cr) and nickel-chromium-molybdenum-aluminum-beryllium alloys (Ni-Cr-Mo-Al-Be).[1,8] Love and Breitman were the first to chemically etch a Ni-Cr alloy using a mixture of nitric acid, hydrochloric acid, and methanol. As a result, the shear bond strength of this etching is greater than that of conventional electrolytic etching.[9] Livaditis also reported greater tensile strength in chemical etching than electrolytic in Ni-Cr-Be alloys.[10] Another study in 1988 by Re et al. stated that chemical etching reduces tensile and shear strength compared to electrolytic etching processes.[11] An 11-years evaluation of chemically etched adhesive bridges showed only 9 of the 46 samples were detached. This result is better than the electrolytic etching treatment, which released 17 of the total 27 samples.[12]

Ninety-nine adhesive bridges studied over 10 years stated the success rate of the perforated bridge was better than the etched one.[13] Priest's research stated that the rate of release adhesive bridges with multiple holes, on average 6.6 years, was higher than those that were chemically and electrolytically etched, namely 5.2 years and 3.4 years.[12] Creuger and Kanter reported a success rate of 49% after 10.5 years for multi-perforated adhesive bridges, while etched was 57% after 10.5 years for nickel-chromium metal alloys.[14]

This article is aimed to explore the difference in tensile bond strength of an adhesive cement resin to an etched and perforated resin-bonded bridges

METHOD

The samples were ten pieces of Ni-Cr alloy with a diameter of 13 mm and a thickness of 1 mm. These ten metal plates are divided into two groups (5 pieces each). In the first group, five holes were given using a drill with a diameter of 1.5 mm and a depth of 0.5 mm. The distance between the holes is 2 mm, with five holes on each plate. After that, these five plates were buried in resin using a pipe as a mold.

Figure 1A Five metal plates with several holes have been buried with resin; **B** Five etched metal plates

In group 2, five metal plates that had been buried in resin, each surface was given metal etching gel (Met-etch Gresco Product Inc, USA) according to manufacturer rules (Fig.1). On the ten metal plates, apply adhesive cement (Multilink N Ivoclar Vivadent AG, Liechtenstein), put it in a tensile tester, and let it sit for 120 seconds until the cement hardens. The inside of the tensile tester, which is in contact with the metal plate, is also cemented. At the top of the puller, a load of 2 kg is given for 5 minutes to pressure distribution. Sink for 24 hours with distilled water before the tensile test. The tensile test is carried out with the Ametek Lloyd instrument (Ametek Inc); the arrow indicates the top of the tensile test tool clamped by the instrument for testing. Fig.2 is a schematic cross-section of the sample in a tensile test.

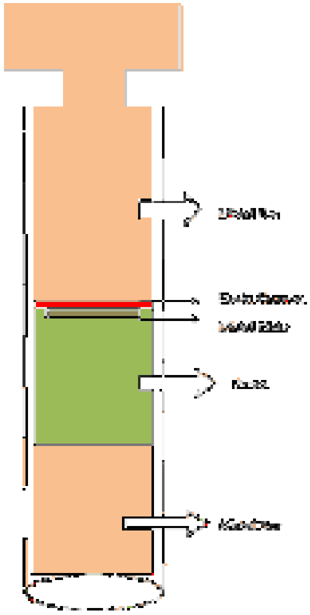

Figure 2 Cross-sectional image of the tensile test tool

RESULT

The two sample groups' average results and standard deviation indicate the value of resistance to tensile tests (table 1).

The average value of the tensile bond strength of etched-metal plates was 0.71012 MPa. In comparison, the average value of the tensile bond strength of perforated-metal plates was 0.56368 Mpa. The results of this study were tested by a t-student using IBM SPSS 22 software (NY, USA) using a 95% confidence level. The result is t-value of 2.75 with p-value = 0.0125.

Table 1 Mean and standard deviation for tensile bond strength

Group	Tensile Bond Strength (MPa)
Etch	0.71012 ± 0.10224
Perforated	0.56368 ± 0.06073

DISCUSSION

The results of this study indicate that the average value of the adhesive strength of the etched metal is higher than perforated, 0.710128 MPa, compared to that with perforated, which is 0.56368 MPa. This result compared to the previous research has a smaller value, Petrie et al.[15] 10.6 MPa; Livaditis[10], 19.5 MPa; and Krueger et al.[16] 28,23 MPa. These results are different because of differences in sample size, number of samples, type of etching used, number of etching applications, in room temperature, types of resin cement, and in research methods.

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The metal has given several holes, resulting in lower adhesive strength in this study. Its retention was limited to the perforated part and was not evenly distributed over the entire metal surface. This result is consistent with the shortcomings of the Rochette bridge because the retention of cement on the bridge wing is limited to the hollow area and not the entire wing surfaces; this weakens the strength of the bridge wing, thereby allowing detachment. Livaditis and Thompson developed the etching technique to improve retention.[4,5,17,18] Improved retention and sealing of the overall surface of the adhesive bridge restoration is the primary goal of etched bridges compared to perforated ones.[17]

The attachment between the adhesive bridge and the abutment teeth requires resin cement that adheres to the enamel and metal framework surface. The tooth surface requires acid etched while the adhesive bridge flange is perforated or etched to form a mechanical bond with the cement.[18] A type of resin cement containing 4-methacryloxyethyl trimellitate anhydride (4-META) monomer can adhere to both tooth and metal surfaces.[18,20] Adhesion to the tooth is achieved by penetration of hydrophilic monomers into the demineralized tooth structure, which forms a mechanical interlocking of the resin against the hydroxyapatite crystals and etched enamel prisms.[20] The bond between resin cement and metal is obtained from the entry of resin cement into tiny pores or micropits on the metal surface that has been etched.[16]

In vitro studies have shown that etched-retainers, both electrolytically and chemically, give higher bonds than those with multiple holes.[21] Retainer given micromechanical treatment is more retentive than macromechanical.[22] This is followed by the results of this study, where the result of micromechanical etched-metal plate were better than macromechanical perforated. Electrolytic etching is 2.9 times more retentive than perforated.[23] Etching is intended to form micromechanical retention by forming micropits to obtain a mechanical relationship between resin and microretentive pits.[24]

Etching on the metal gives better bonding strength than perforation because etching is more evenly distributed and extends over the entire metal surface, forming microporosity to produce micromechanical adhesion with resin cement.[25,26] Etching on nonprecious metal alloys will form microscopic surface roughness on metal components most sensitive to corrosion.[5] Retention is obtained from the mechanical connection of resin cement that enters the microporosity formed.[24]

It is concluded that the tensile bond strength of the etched metal is higher when compared to perforation.

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