

# The effect of different dentin hypersensitivity treatments on the shear bond strength of self-adhesive resin to dentin

Ceyda Akın<sup>α</sup>, Özgür İnan<sup>β</sup>

*Selcuk Dent J*, 2017; 4: 110-115 (Doi: 10.15311/selcukdentj.318612)

Başvuru Tarihi: 06 Mayıs 2017  
Yayına Kabul Tarihi: 12 Haziran 2017

## ABSTRACT

### The effect of different dentin hypersensitivity treatments on the shear bond strength of self-adhesive resin to dentin

**Background:** This in vitro study evaluated the shear bond strength of self adhesive resin cement to dentin with different dentin hypersensitivity treatments.

**Methods:** Forty-eight dentin specimens were randomly divided into four groups (n=12). (1) Group C (control); (2) Group G (treated with Gluma Desensitizer); (3) Group E (treated with Er:YAG laser); (4) Group E+G (treated with Er:YAG laser following Gluma Desensitizer). Flowable self adhesive resin cement was applied to dentin surface and shear bond strength tests were performed. The mean SBS values were calculated and data were analyzed by one-way ANOVA test and Post Hoc test.

**Results:** Statistical analysis revealed that Group E statistically significant lower bond strength values than the other desensitizing treatment groups tested ( $p < 0.005$ ). While there were no significant differences among the other groups ( $p > 0.05$ ).

**Conclusion:** The shear bond strength of self-adhesive resin will be decrease if dentin surface is irradiated with Er:YAG laser

## KEYWORDS

Dentin hypersensitivity, erbium:yttrium-aluminum-garnet (Er:YAG) laser, gluma, self-adhesive resin, bond strength

## ÖZ

### Self adeziv rezin simanın bağlanma dayanımına farklı dentin hassasiyet tedavilerinin etkisi

**Amaç:** Bu in vitro çalışmada farklı dentin hassasiyet tedavilerinin self adeziv rezin simanın bağlanma dayanımına etkisi değerlendirildi.

**Gereç ve Yöntemler:** Kırk sekiz dentin örnek rastgele dört gruba ayrıldı (n=12). Grup K (kontrol); (2) Grup G (Gluma hassasiyet giderici uygulaması); (3) Grup E (Er:YAG lazer uygulaması); (4) Grup E+G (Er:YAG lazer uygulamasını takiben Gluma uygulaması). Akıcı self adeziv rezin siman dentin yüzeylerine yapıştırıldı ve makaslama bağlanma testleri yapıldı. Ortalama makaslama bağlanma değerleri hesaplandı ve veriler tek yönlü varyans analizi ve post hoc testiyle analiz edildi.

**Bulgular:** İstatistiksel analiz değerlendirildiğinde Grup E, diğer hassasiyet giderici gruplardan istatistiksel olarak anlamlı ölçüde düşük bağlanma değerleri gösterirken ( $p < 0.005$ ), diğer gruplar arasında anlamlı fark bulunmadı ( $p > 0.05$ ).

**Sonuç:** Dentin yüzeyi Er:Yag lazer ile muamele edilecekse, self adeziv rezinin bağlanma dayanımı azalacaktır.

## ANAHTAR KELİMELER

Dentin hassasiyeti, erbium:yttrium-aluminum-garnet (Er:YAG) lazer, gluma, self adeziv rezin, bağlanma dayanımı

Dentin sensitivity, the most commonly diagnosed type of pain in clinical dentistry, is a dental pain which is sharp in character and of short duration arising from dentin exposed to various chemical and physical factors.<sup>1,2</sup> Tooth enamel and cement surrounding dentin creates a protective layer for nerves. In the case of hard tissue loss as a result of several dental procedures such as cavity and crown preparations, dentinal tubules become exposed to oral cavity and a direct connection occurs between environmental stimuli and dental pulp.<sup>3,4</sup>

The most commonly accepted argument in the formation mechanism of dentin sensitivity is Hydrodynamic Theory.<sup>5</sup> According to this theory, thermal, osmotic and chemical stimuli stops dental

fluid flow in dentinal tubules, which stimulates nerve endings in dentin or pulp and dental pain occurs.<sup>6</sup> In order to lower fluid flow in dentinal tubules, blocking tubule openings or nerve conduction are methods used in sensitivity treatment.<sup>7</sup> To achieve this purpose, Gluma Desensitizer, one of the most commonly used desensitizer agents, is a glutaraldehyde-based substance.<sup>8,9</sup> Gluma is used to block exposed dentinal tubules by helping plasma protein in dentin fluid precipitate, and diminish permeability by the presence of HEMA.<sup>10,11</sup> In addition after tooth preparation, the diffusion of monomers to dentin is probably to be accelerated glutaraldehyde was combined with hydroxyethylmethacrylate (HEMA), advanced bond strengths were acquired.<sup>11-13</sup>

<sup>α</sup> Necmettin Erbakan Üniversitesi Diş Hekimliği Fakültesi Protetik Diş Tedavisi AD, Konya

<sup>β</sup> Selçuk Üniversitesi Diş Hekimliği Fakültesi Protetik Diş Tedavisi AD, Konya

In the management of dentinal sensitivity, laser therapy is an alternative method: erbium:yttrium-aluminum-garnet (Er:YAG) laser reducing the diameters of dentin tubules with the partial obliteration of the tubules below the ablation threshold.<sup>14</sup> Er:YAG-irradiated dentine is characterized by denatured collagen fibrils and a fragile surface structure.<sup>15</sup> The bond strength of adhesives to Er:YAG-irradiated dentin may be improve.<sup>16</sup>

As a consequence of slower dentinal fluid flow, dentin sensitivity may lower. Although dentin sensitivity treatments may make patients have less complaints, its effects into the shear bond strength of adhesive cementation should not be ignored. In practice, adhesive cementation is commonly used in desensitizer treatments. Since these treatments may change the characteristics of dentinal tubules, a later adhesive restoration practice may affect its shear bond strength.<sup>17</sup> In literature, a few studies examine the effects of desensitizer implementations into the shear bond strength of adhesive resin. Therefore, the aim of this in vitro study is to determine the effects of Er:YAG laser and Glutaraldehyde-HEMA into the shear bond strength of self-adhesive resin cement.

## MATERIALS AND METHODS

In the study 48 pieces of healthy permanent third molar teeth were included. Soft tissue remains on teeth were cleaned by periodontal scaler and soaked in 0.2% timol solution. By using auto-polymerizing acrylic resin, the teeth were placed on their buccal surfaces collaterally and buried into cylindrical plastic containers. Then, to reveal their buccal dentinal tissue, buccal enamel tissue was cut by diamond saw (low speed) under water cooling and in order to obtain standard smear layers, buccal surfaces were grinded underwater by using 600 grit silicone carbide sandpaper.

### Surface treatment of dentin specimens

The samples were randomly divided into 4 groups (n=12):

1. Control group: No implementation was realized.
2. Gluma implementation (Gluma Desensitizer, Heraeus Kulzer, Hanau, Germany): Gluma agent was used on dentinal surface by using a cotton brush and kept on the surface for about 30-60 seconds. Then, it was dried and rinsed till the film layer on the surface was removed.
3. Er:YAG laser irradiation: To simulate clinical conditions, dentinal surfaces were manually irradiated by scanning movements performed perpendicular to and approximately 6 mm away from the surface under the following conditions: 90 mJ, 2 Hz, short pulse mode for 60 seconds, two times.
4. Er:YAG laser irradiation and one of desensitizer implementation (Er:YAG + Gluma): Er:YAG laser and Gluma implementations were used respectively.

After storage in artificial saliva for 14 days at 37°C, all the specimens were rinsed with distilled water. Then, cylindrical teflon molds, 3mm in diameter and 2.5 mm in height, were placed on dentinal surface and treated by self-adhesive resin RelyX U200 (3M ESPE, ABD) in accordance with manufacturer's instructions.

### Test procedure for shear bond strength

All prepared samples were soaked into distilled water set at 37°C for 24 hours and then shear bond strength was measured using a universal testing machine (TSTM 02500, Elisa Ltd, Istanbul, Turkey) at 0.5mm/min crosshead until fracture occurred. Shear bond strength values (MPa) were calculated as the ratio of the fracture load and bonding area.

### Statistical analysis

One-way ANOVA and Post-hoc Tukey HSD test were used to determine statistical differences in SBS between the desensitizing treatment and control groups at a level of  $\alpha=0.05$ .

### SEM Analysis

One specimen from each group, was randomly chosen for scanning electron microscopic (SEM) examination. The specimens sputter-coated with gold-palladium and visualized with a magnification (2000x) adequate to evaluate the surface characteristics of dentin sites of the debonded.

## RESULTS

Table 1 shows the mean values and standard deviations of the shear bond strength (MPa). The results of the statistical analysis showed significant differences in mean values of bond strength for the different desensitizing treatment groups. The bond strength for the Er:YAG irradiated group had significantly lower values than the other groups ( $p<0.05$ ). Gluma group showed comparable high values although no significant differences were observed between the control and Er:YAG+Gluma groups ( $p>0.05$ ).

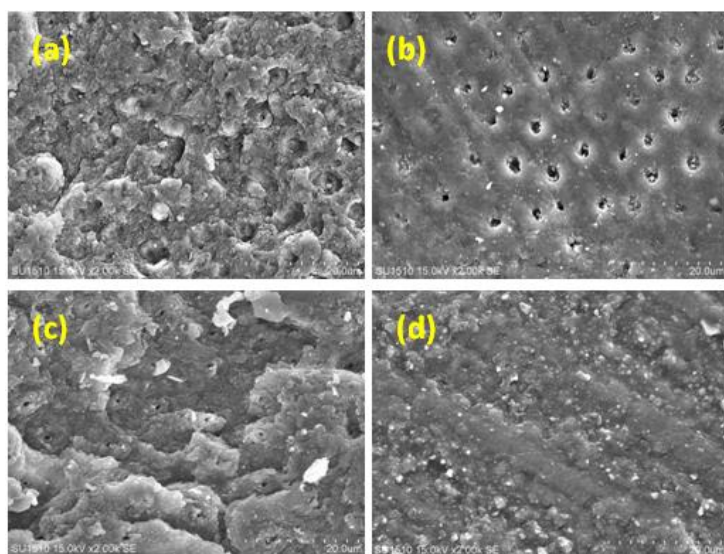
**Table 1.**

**Mean and SD values for shear bond strength (MPa)**

Control	Gluma	Er:Yag	Er:Yag+Gluma
15,34±3,95	17,2±4,56	8,19±2,8	13,91±3,86

## SEM Analysis

In the SEM examination, Gluma group some partial tubules were occluded, some dentin tubules were generally observed to be open (Figure 1b), Er:YAG laser was treated (Figure 1c) and Er:YAG + Gluma (Figure 1d) was treated, contracted and occluded dentin tubules were clearly observed. Er:YAG irradiated specimens showed narrowing and degradation in the diameter of the dentin tubules. In control group, fracture surface predominantly showed cohesive failure (Figure 1a). In contrast, the fracture patterns for the other groups adhesive and mixed failure.



**Figure 1.**

SEM image of dentin surface Control group (a), Gluma group (b), Er:Yag group (c), Er:Yag+Gluma group (d)

## DISCUSSION

Various treatment options are available to be used in dentin sensitivity treatment.<sup>18</sup> Therefore, mostly, desensitizer agents are effectively used, however, their efficacy may rapidly diminish.<sup>19</sup> Previous clinical studies on laser therapy to lower dentin sensitivity symptoms had been published and it had been shown to reduce dentin hypersensitivity.<sup>2,20-22</sup> Er:YAG laser is absorbed by water molecules in hydroxyapatite. This condition causes ablation on dentin surface and causes a partial coating in dentinal tubules.<sup>22</sup> However, a few studies focus on the effects of Er:YAG laser and desensitizer application into shear bond strength between resin material and dentin. Makkar *et al*<sup>21</sup>, assessed the effects of Er:YAG laser and Thermokind-F Gel desensitizer on tensile bond strength of self-etch adhesive to dentin and reported that Er:YAG lasers decreased the tensile bond strength of self-etch adhesive to dentin. Er:YAG-irradiated dentin is coated with laser-modified dentin layer which is about 3-5  $\mu\text{m}$  and microfractures are located underneath the dentin surface.<sup>15,23</sup> Yazıcı *et al*<sup>4</sup> showed that Er:YAG laser therapy reduced the bond strength of the self-etch adhesives to dentin. Our

findings also agrees with similar reported results in which the bond strength of different adhesive systems applied to Er:YAG laser-treated dentin was tested until failure, in micro-tensile or shear mode. According to authors in this denatured dentin layer without water is characterized with high acid resistance and the composition and structure of the collagen presents a modified structure and exposed collagen fibrils are hydrolyzed.<sup>24,25</sup> We assume that the Er:YAG laser irradiation to dentin may have a negative effect on dentin bonding and a lower level of shear bond strength is considered as this condition prevents monomer diffusion into dentinal tubules.

In dentins on which both Gluma and Er:YAG were used, a higher level of shear bond strength was measured than Er:YAG groups in current study. According to this result Gluma improved the bonding strength with a self adhesive to Er:YAG irradiated dentin. Gluma desensitizer agent includes Glutaraldehyde and HEMA. Glutaraldehyde reacts with proteins producing precipitation on the dentin surface.<sup>26</sup> The aldehyde group of glutaraldehyde cross-linking with the amino groups in dentin collagen resulting in protein fixation indicates that glutaraldehyde may bond to dentin collagen fibrils.<sup>27</sup> HEMA plays an important role as a hardening agent preventing any subsequent shrinkage and undergoes a chemical reaction between its ester functional group and dentin collagen.<sup>28</sup> In addition HEMA decreases surface tension of water and increases dentinal monomer diffusion<sup>12</sup> by using HEMA implementation on dentin surface which was structurally modified by laser irradiation, the level of shear bond strength increases because resin diffusion into the dentinal tubules is simplified<sup>29</sup>. Moreover, it was also reported that owing to the reaction between phosphate and glutaraldehyde in Gluma, Gluma desensitizer agent combined with self-adhesive resin cement provided a strong and suitable shear bond.<sup>13</sup> Omae *et al*<sup>16</sup> who reported that although application of Er:YAG-irradiated dentine reduced, the Er:YAG laser irradiation followed by application of Gluma increased the bond strength of the self-etching priming adhesives. Although pretreatment on dentin surface with Gluma to increased shear bond strength of self adhesive resin cement to dentin, were not statistically significant difference control and

Er:YAG + Gluma groups in this study. Acar *et al* in 2012<sup>30</sup> evaluated the effect of Gluma Aqua-Prep F, BisBlock, Cervitec Plus, Smart Protect, and Nd:YAG laser desensitizer on microtensile bond strength of RelyX U200 self-adhesive cement to dentin and reported that Gluma increased the microtensile bond strength, but not significantly; which was in agreement with our findings. However, they performed, test of microtensile, while we performed test of shear bond. In addition Aranha *et al*<sup>31</sup> compared the effect of different dentin desensitizers on microtensile bond strength of composite resin and concluded that implementation of Gluma had no significant effect on microtensile bond strength. In previous studies, it was reported that dentinal fluid flow decreases shear bond strength since it affects adhesive resin diffusion into dentinal tubules.<sup>32,33</sup> Despite the fact that desensitizer treatments causing tubular blockage restricts hybridization, the blockage of dentinal fluid flow may provide positive effects.<sup>34</sup>

Adhesive cements have higher technical sensitivity and their clinical achievement may be threatened by technical errors.<sup>35</sup> Moreover adhesive systems including acid implementation phases may stimulate the pain of patients suffering from dentin sensitivity.<sup>36</sup> Recently, innovative self-adhesive methods which do not require surface preparations and do provide easier treatments have been introduced. RelyX U200 self adhesive resin cement used in this study, as a one-step solution, spares any pre-treatment steps like etching, priming and bonding.<sup>37</sup> Self-adhesive systems include acidic monomer in their formation and they do not require another acid implementation phase. In addition, the fact that these self-adhesive systems are hydrophilic makes them humidity-tolerant and improves adaptation to tooth structure.<sup>34</sup> In contrary to these advantages, its dentin demineralization depth and hybridization abilities are limited.<sup>38</sup> Although our findings in the study open up new perspectives, since shear bond strength may be affected due to the reasons that dentinal fluid flow and pulpal pressure may not exist in extracted teeth, clinical performance for in vivo conditions may not be expected. Therefore, we believe that further in vivo studies are required to evaluate the potential effects of dentin sensitivity treatment including Gluma and Er:YAG laser into adhesive restorative materials dentin bonding.

## CONCLUSION

Application of Gluma desensitizing and Gluma desensitizing to Er:YAG-irradiated dentin did not affect the shear bond strength when used a self-adhesive resin cement. The Er-YAG laser created a laser-modified layer that adversely affects adhesion to dentin.



## REFERENCES

1. Birang R, Kaviani N, Mohammadpour M, Abed AM, Gutknecht N, Mir M. Evaluation of Nd:YAG laser on partial oxygen saturation of pulpal blood in anterior hypersensitive teeth. *Lasers Med Sci* 2008; 23: 291–4.
2. Eyyuboglu GB, Yesilyurt C. The effect of dentin desensitizing agents on the shear bond strength of a one step self-etch adhesive to dentin. *Cumhuriyet Dent J* 2014; 17: 334-49.
3. Sailer I, Oendra AE, Stawarczyk B, Hämmerle CH. The effects of desensitizing resin, resin sealing, and provisional cement on the bond strength of dentin luted with self-adhesive and conventional resin cements. *J Prosthet Dent* 2012; 107: 252-60.
4. Yazıcı E, Gurgan S, Gutknecht N, Imazato S. Effects of erbium:yttrium–aluminum–garnet and neodymium:yttrium–aluminum–garnet laser hypersensitivity treatment parameters on the bond strength of self-etch adhesives. *Lasers Med Sci* 2010; 25: 511–6.
5. Schwarz F, Arweiler N, Georg T, Reich E. Desensitizing effects of an Er:YAG laser on hypersensitive dentin. A controlled, prospective clinical study. *J Clin Periodontol* 2002; 29: 211–5.
6. Brannstrom M. Etiology of dentin hypersensitivity. *Proc Finn Dent Soc* 1992; 88: 7-13.
7. Porto IC, Andrade AK, Montes MA. Diagnosis and treatment of dentinal hypersensitivity. *J Oral Sci* 2009; 51: 323-32.
8. Sailer I, Tettamanti S, Stawarczyk B, Fischer J, Hämmerle CH. In vitro study of the influence of dentin desensitizing and sealing on the shear bond strength of two universal resin cements. *J Adhes Dent* 2010; 12: 381-92.
9. Felton DA, Bergenholtz G, Kanoy B. Evaluation of the desensitizing effect of Gluma Dentin Bond on teeth prepared for complete-coverage restorations. *Int J Prosthodont* 1991; 4: 292-298.
10. Swift EJ Jr, Lloyd AH, Felton DA. The effect of resin desensitizing agents on crown retention. *J Am Dent Assoc* 1997; 128: 195-200.
11. Kolker JL, Vargas MA, Armstrong SR, Dawson DV. Effect of desensitizing agents on dentin permeability and dentin tubule occlusion. *J Adhes Dent* 2002; 4: 211-21.
12. Nakabayashi N, Watanabe A, Gendusa NJ. Dentin adhesion of modified 4-META/MMA-TBB resin: function of HEMA. *Dent Mat* 1992; 8: 259-64.
13. Stawarczyk B, Hartmann R, Hartmann L, Roos M, Özcan M, Sailer I. The Effect of Dentin Desensitizer on Shear Bond Strength of Conventional and Self-adhesive Resin Luting Cements After Aging. *Operative Dentist* 2011; 36: 492-501.
14. Aranha ACC, Domingues FB, Franco VO, Gutknecht N, Eduardo CP. Effects of Er:YAG and Nd:YAG lasers on dentin permeability in root surfaces: a preliminary in vitro study. *Photomed Laser Surg* 2005; 23: 504–8.
15. Ceballo L, Toledano M, Osorio R, Tay FR, Marshall GW. Bonding to Er-YAG-laser-treated dentin. *J Dent Res* 2002; 81: 119–22.
16. Omae M, Inoue B, Itota T, Finger WJ, Inoue M, Tanaka K, Yamamoto K, Yoshiyama M. Effect of a desensitizing agent containing glutaraldehyde and HEMA on bond strength to Er:YAG laser-irradiated dentine. *J Dent Res* 2007; 35: 398–402.
17. Pashley EL, Tao L, Pashley DH. Effects of oxalate on dentin bonding. *Am J Dent* 1993; 6: 116-18.
18. Kishore A, Mehrotra KK, Saimbi CS. Effectiveness of desensitizing agents. *J Endod* 2002; 28: 34-5.
19. Ritter AV, de LDW, Miguez P, Caplan DJ, Swift EJ, Jr. Treating cervical dentin hypersensitivity with fluoride varnish: a randomized clinical study. *J Am Dent Assoc* 2006; 137: 1013-20.
20. Lan WH, Lee BS, Liu HC, Lin CP. Morphologic study of Nd:YAG laser usage in treatment of dentinal hypersensitivity. *J Endod* 2004; 30: 131-4.
21. Makkar S, Goyal M, Kaushal A, Hedge V. Effect of desensitizing treatments on bond strength of resin composites to dentin – an in vitro study. *J Conserv Dent* 2014; 17: 458-61.
22. Birang R, Poursamimi J, Gutknecht N, Lampert L, Mir M. Comparative evaluation of the effects of Nd:YAG and Er:YAG laser in dentin hypersensitivity treatment. *Lasers Med Sci* 2007; 22: 21– 4.
23. Bachmann L, Diebolder R, Hibst R, Zetzl DM. Changes in chemical composition and collagen structure of dentine tissue after erbium laser irradiation. *Spectrochim Acta A Mol Biomol Spectrosc* 2005; 61: 2634–9.
24. Lehmann N , Degrange M. Effect of four dentin desensitizer on the shear bond strength of three bonding systems. *European Cells and Materials* 2005; 9: 52-3.
25. Ritter AV, Heymann HO, Swift EJ Jr, Perdiago J, Rosa BT. Effects of different re-wetting techniques on dentin shear bond strengths. *J Esthet Dent* 2000; 12: 85-96.
26. Van Meerbeek B, Yoshida Y, Lambrechts P, Vanherle G, Duke ES, Eick JD, et al. A TEM study of Two water based adhesive systems bonded to Dry and Wet Dentin. *J Dent Res* 1998; 77: 50-9.
27. Perdigao J, Van Meerbeek B, Lopes MM, Ambrose WW. The effect of a re-wetting agent on dentin bonding. *Dent Mater* 1999; 15: 282-95.

28. Mazzitelli C, Monticelli F, Osorio R, Casucci A, Toledano M, Ferrari M. Effect of simulated pulpal pressure on self-adhesive cements bonding to dentin. *Dental Materials* 2008; 24: 1156-63.
29. Sauro S, Pashley DH, Montanari M, Chersoni S, Carvalho RM, Toledano M. Effect of simulated pulpal pressure on dentin permeability and adhesion of self-etch adhesives. *Dent Mater* 2007; 23: 705-13.
30. Perdigao J. Dentin bonding-variables related to the clinical situation and the substrate treatment. *Dent Mater* 2010; 26: 24-37.
31. Brännström M, Linden LA, Johnson G. Movement of dentinal and pulpal fluid caused by clinical procedures. *J Dent Res* 1968; 47: 679-82.
32. Acar O, Tuncer D, Yuzugullu B, Celik C. The effect of dentin desensitizers and Nd:YAG laser pre-treatment on microtensile bond strength of self-adhesive resin cement to dentin. *J Adv Prosthodont* 2014; 6: 88-95.
33. Peumans M, De Munck J, Van Landuyt K, Lambrechts P, Van Meerbeek B. Three-year clinical effectiveness of a two-step self-etch adhesive in cervical lesions. *Eur J Oral Sci* 2005; 113: 512-8.
34. Schein MT, Bocangel JS, Nogueira GE, Schein PA. Sem evaluation of the interaction pattern between dentin and resin after cavity preparation using ER:YAG laser. *J Dent* 2003; 31: 127-35.
35. Giachetti L, Scaminaci Russo D, Scarpelli F, Vitale M. SEM analysis of dentin treated with the ER:YAG laser: a pilot study of the consequences resulting from laser use on adhesion mechanisms. *J Clin Laser Med Surg* 2004; 22: 35-41.
36. RelyXTM U200. Self-Adhesive Resin Cement, Technical Data Sheet 3M ESPE; St. Paul; MN; USA
37. Aranha AC, Siqueira Junior Ade S, Cavalcante LM, Pimenta LA, Marchi GM. Microtensile bond strengths of composite to dentin treated with desensitizer products. *J Adhes Dent* 2006; 8: 85-90.
38. Lawaf S, Jalalian E, Roshan R, Azizi A. Effect of GLUMA desensitizer on the retention of full metal crowns cemented with Rely X U200 self-adhesive cement. *J Adv Prosthodont* 2016; 8: 404-410.

Corresponding Author:

Yrd.Doç.Dr. Ceyda AKIN  
Necmettin Erbakan Üniversitesi  
Diş Hekimliği Fakültesi  
Protetik Diş Tedavisi AD  
Karatay, Konya, Türkiye  
GSM: +90 532 367 08 10  
Tel : +90 332 220 00 26  
Faks: +90 332 220 00 45