

LUCAS SILVEIRA MACHADO and RODOLFO BRUNIERA ANCHIETA

SELF-ETCH ADHESIVES SYSTEMS

Following this section of articles, as in previous editions, the objective has been to summarize some important topics discussed and published in the main indexed journals, addressing to this section the main evidences on the use of self-etching adhesive systems. Adhesion to dentin and enamel are one of the most studied subjects in dentistry, with a notable evolution of materials and techniques over the years. Not needing the conventional acid etching of the tooth structure to penetrate the self-etch adhesive may seem to be a great technical advantage, since it may lessen possible errors arising from improper acid etching of the dentin or enamel. However, it is important to address based on laboratory and clinical evidence, the behavior of the self-etch adhesives when applied to enamel. The question of the many clinicians is the need of selective etching of enamel prior use the self-etch adhesives.

Thus, some important articles published in this topic was select in the literature, and the results and clinical considerations were point out. In summary, they discussed the behavior of the use of self-etching adhesive systems, with or without selective etching of the enamel, also comparing the behavior of conventional adhesive systems.

The first article compared conventional adhesive systems with self - etching adhesive systems, through a systematic review of articles that evaluated the behavior of these materials. The article was published in the Journal of Dentistry in the year 2017.

INFLUENCE OF ADHESIVE STRATEGY ON CLINICAL PARAMETERS IN CERVICAL RESTORATIONS: A SYSTEMATIC REVIEW AND META-ANALYSIS.

Schroeder M, Correa IC, Bauer J, Loguercio AD, Reis A.

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OBJECTIVES: We aimed to answer the following PICO question: “Is the risk of postoperative sensitivity (POS), retention rates and marginal discoloration of composite restorations [CR] bonded with self-etch (SE) in non-carious

cervical lesions (NCCLs) of adults equals to etch-and-rinse (ER) adhesives?”.

METHODS: A comprehensive search was performed in May 2016 in the MEDLINE, Scopus, Web of Science, LILACS, BBO and Cochrane Library and SIGLE, abstracts of IADR, unpublished and ongoing trials registries, dissertations and theses without restrictions. Only randomized clinical trials that compared composite resin restorations placed with self-etch and etch-and-rinse in NCCLs were included. After removal of duplicates and non-eligible articles, 50 articles from 42 studies (follow-ups of the same study were merged) remained for synthesis of the risk of bias (Cochrane Risk of bias tool).

RESULTS: Thirteen studies were at “high” risk of bias, yielding 29 studies for meta-analysis. No difference on the POS after restoration placement (risk ratio [RR] 1.04; 95% CI 0.81 to 1.34) as well as in the retention rates for all follow-up periods was observed. The etch-and-rinse approach produced less marginal discoloration at 18 months to 2 years (RR 1.51; 95% CI 1.21 to 1.90) and at 4 to 5 years (RR 1.81; 95% CI 1.28 to 2.55) ($p < 0.0007$).

CONCLUSIONS: The adhesive strategy did not influence the POS and the retention rates of composite resin in NCCLs in any of the follow-up periods; but less marginal discoloration was found in etch-and-rinse adhesives.

COMMENTS: Composite resin restorations performed with self-etching and conventional adhesives produce similar results, mainly by comparing retention rates and postoperative sensitivity. However, using conventional adhesives can reduce marginal discoloration. These findings were based on restorations performed with a wide range of clinical procedures, such as cavity preparation (no cavity preparation, enamel bevel, dentin roughness, dentin grooves, and a combination thereof), and operative field (rubber dam or cotton rollers). These variables exist due to the lack of randomized clinical trials. The control of these variables is fundamental to the definition of an evidence, and thus, randomized clinical studies are increasingly necessary to better observe the behavior of these materials.

The second article evaluated clinically the behavior of restorations after 8 years, comparing self-etching adhesive systems used with or without selective conditioning. The article was published in Dental Materials in 2010.

EIGHT-YEAR CLINICAL EVALUATION OF A 2-STEP SELF-ETCH ADHESIVE WITH AND WITHOUT SELECTIVE ENAMEL ETCHING.

Peumans M, De Munck J, Van Landuyt KL, Poitevin A, Lambrechts P, Van Meerbeek B.

Dent Mater. 2010 Dec;26(12):1176-84.

doi: 10.1016/j.dental.2010.08.190. Epub 2010 Oct 13.

OBJECTIVES: The objective of this randomized controlled clinical trial was to evaluate the 8-year clinical performance of a mild 2-step self-etch adhesive in non-carious Class-V lesions with and without prior selective phosphoric acid-etching of the enamel cavity margins.

METHODS: A total of 100 non-carious Class-V lesions in 29 patients were restored with Clearfil AP-X (Kuraray). The composite restorations were bonded following two different approaches: (1) application of Clearfil SE (Kuraray) following a self-etch approach (control group; C-SE non-etch), (2) selective phosphoric acid-etching of the enamel cavity margins before application of Clearfil SE (experimental group; C-SE etch). The restorations were evaluated after 6 months, 1, 2, 3, 5 and 8 years of clinical service regarding their retention, marginal integrity and discoloration, caries occurrence, preservation of tooth vitality and post-operative sensitivity.

RESULTS: The recall rate at 8 years was 76%. Only two restorations, one of the C-SE non-etch group and one of the C-SE etch group, were clinically unacceptable due to loss of retention leading to a retention rate and a clinical success rate of 97% in both groups. Aging of the restorations was characterized by an increase in the percentage of restorations with a small but clinically acceptable marginal defect (C-SE non-etch: 92%; C-SE etch: 84%) and/or a superficial marginal discoloration (C-SE non-etch: 44%; C-SE etch: 28%). At the enamel side, the presence of small marginal defects (C-SE non-etch: 86%; C-SE etch: 65%) and superficial marginal discoloration (C-SE non-etch: 11%; C-SE etch%) was more frequently noticed in the control group than in the experimental group. The difference, however, was only statistically significant for the presence of superficial marginal discoloration (McNemar, $p=0.01$).

COMMENTS: After 8 years of clinical functioning, the clinical effectiveness of Clearfil SE remained excellent, with selective acid-etching of the enamel cavity margins only having some minor positive effect on marginal integrity and absence of marginal discoloration at enamel.

The clinical efficacy of Clearfil SE, a 2-step self-etching adhesive, proved to be excellent and reliable over 8 years. Selective phosphoric acid conditioning of the enamel margins had only a small positive effect on secondary clinical parameters, such as a lower incidence of small marginal defects / discoloration on the enamel side. These marginal deficiencies was considered clinically acceptable, and did not require any restorative intervention.

The third article tested seven universal adhesives, used with different technique strategies, evaluating the effect of previous conditioning and passive or active application mode. The article was published in the Journal of Dentistry in the year 2015.

DOES ACTIVE APPLICATION OF UNIVERSAL ADHESIVES TO ENAMEL IN SELF-ETCH MODE IMPROVE THEIR PERFORMANCE?

Loguercio AD, Muñoz MA, Luque-Martinez I, Hass V, Reis A, Perdigão J.

J Dent. 2015 Sep;43(9):1060-1070. doi: 10.1016/j.jdent.2015.04.005. Epub 2015 Apr 20.

OBJECTIVES: To evaluate the effect of adhesion strategy on the enamel microshear bond strengths (μ SBS), etching pattern, and in situ degree of conversion (DC) of seven universal adhesives.

METHODS: 84 extracted third molars were sectioned in four parts (buccal, lingual, proximal) and divided into 21 groups, according to the combination of the main factors adhesive

(AdheSE Universal [ADU], All-Bond Universal [ABU], Clearfil Universal [CFU], Futurabond U [FBU], G-Bond Plus [GBP], Prime&Bond Elect [PBE], and Scotchbond Universal Adhesive [SBU]), and adhesion strategy (etch-and-rinse, active self-etch, and passive self-etch). Specimens were stored in water (37°C/24h) and tested at 1.0mm/min (μ SBS). Enamel-resin interfaces were evaluated for DC using micro-Raman spectroscopy. The enamel-etching pattern was evaluated under a field-emission scanning electron microscope (direct and replica techniques). Data were analyzed with two-way ANOVA and Tukey's test ($\alpha=0.05$).

RESULTS: Active self-etch application increased μ SBS and DC for five out of the seven universal adhesives when compared to passive application ($p<0.001$). A deeper enamel-etching pattern was observed for all universal adhesives in the etch-and-rinse strategy. A slight improvement in etching ability was observed in active self-etch application compared to that of passive self-etch application. Replicas of GBP and PBE applied in active self-etch mode displayed morphological features compatible

with water droplets. The DC of GBP and PBE were not affected by the application/strategy mode.

CONCLUSIONS: In light of the improved performance of universal adhesives when applied actively in SE mode, selective enamel etching with phosphoric acid may not be crucial for their adhesion to enamel.

COMMENTS: The active application of universal adhesives in self-etch mode may be a practical alternative to enamel etching in specific clinical situations.

The active application of universal adhesives in the self-etching mode can be a practical alternative to the enamel conditioning in specific clinical situations. The active application mode of universal adhesives on the enamel increases the degree of conversion of the adhesive at the interface as well as the adhesive bond strength. The active application of universal adhesives in SE (self-etching) mode may be a viable alternative for selective enamel conditioning in terms of enamel adhesion.

The fourth article clinically evaluated the effects of selective enamel conditioning for the use of self-etching adhesive. The article was published in the Journal of Dentistry in the year 2016.

SELECTIVE ENAMEL ETCHING IN CERVICAL LESIONS FOR SELF-ETCH ADHESIVES: A SYSTEMATIC REVIEW AND META-ANALYSIS.

Szesz A, Parreiras S, Reis A, Loguercio A.

J Dent. 2016 Oct;53:1-11.

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OBJECTIVES: To identify if selective etching of enamel (SEE) margins improves the retention rates and marginal discoloration of cervical composite restorations in non-carious cervical lesions (NCCLs) of adult patients.

MATERIALS AND METHODS: MEDLINE, Scopus, Web of Science, LILACS, BBO Library, Cochrane Library and SIGLE were searched without restrictions, as well as IADR abstracts and gray literature via trial registries. Dissertations and theses were searched using the ProQuest Dissertations and Periódicos Capes Theses databases.

We included randomized clinical trials that compared the clinical effectiveness of SEE using the self-etch adhesive for direct composite resin restorations in NCCLs in the permanent dentition.

RESULTS: After removal of duplicates, 2689 articles were identified. Following screening of abstracts, 10 studies remained in the qualitative synthesis. Seven were considered to be at “low” risk of bias. The report of the studies varied from 1 to 5 years. Except for one-year follow-up, there was a significantly lower marginal discoloration and marginal adaptation during all follow-up periods. Significantly less loss of retention of restorations at the 3-year follow-up was observed with the selective enamel etching technique.

CONCLUSIONS: Selective enamel prior to application of self-etch adhesive systems in NCCLs might improve clinical performance of resin-composite cervical restorations, although further long-term research is required to confirm this.

COMMENTS: Selective enamel etching prior to application of self-etch adhesive systems in NCCLs can produce composite restorations with higher longevity.

Selective enamel etching prior to the application of self-etching adhesive systems in NCCLs can produce composite restorations with longer longevity, with lower rates of marginal

discoloration, better marginal integrity, and higher retention rates. According to this results, this adhesion strategy should be used whenever is possible.

The fifth article also studied the selective conditioning, but in occlusal cavities, class I, on the effect of thermomechanical aging. The article was published in Operative Dentistry in the year 2012.

**SELECTIVE ENAMEL ETCHING:
EFFECT ON MARGINAL ADAPTATION
OF SELF-ETCH LED-CURED BOND
SYSTEMS IN AGED CLASS I COMPOSITE
RESTORATIONS.**

Souza-JuniorEJ1,PrietoLT,AraújoCT,PaulilloLA.

Oper Dent. 2012 Mar-Apr;37(2):195-204.

doi: 10.2341/11-184L. Epub 2012 Feb 7.

OBJECTIVES: The aim of this study was to evaluate the influence of previous enamel etch and light emitting diode (LED) curing on gap

formation of self-etch adhesive systems in Class I composite restorations after thermomechanical aging (TMA).

MATERIAL AND METHODS: Thus, on 192 human molars, a box-shaped Class I cavity was prepared maintaining enamel margins. Self-etch adhesives (Clearfil SE and Clearfil S3) were used to restore the preparation with a microhybrid composite. Before application of the adhesives, half of the teeth were enamel etched for 15 seconds with 37% phosphoric acid; the other half were not etched. For the photoactivation of the adhesives and composite, three light-curing units (LCUs) were used: one polywave (Ultra-Lume LED 5, UL) and two single-peak (FlashLite 1401, FL and Radium-cal, RD) LEDs. After this, epoxy resin replicas of the occlusal surface were made, and the specimens were submitted to TMA. New replicas were made from the aged specimens for marginal adaptation analysis by scanning electron microscopy. Data were submitted to Kruskal-Wallis and Wilcoxon tests ($\alpha=0.05$).

RESULTS: Before TMA, when enamel was etched before the application of S3, no gap formation was observed; however, there were gaps at the interface for the other tested conditions, with a statistical difference ($p\leq 0.05$). After TMA, the selective enamel etching previous to the S3 application, regardless of the LCU, promoted higher marginal adaptation compared to the other tested groups ($p\leq 0.05$). Prior to TMA, higher marginal integrity was observed, in comparison with specimens after TMA ($p\leq 0.05$). With regard to Clearfil SE and Clearfil Tri-S cured with FL, no differences of gap formation were found between before and after

aging (5.3 ± 3.8 and 7.4 ± 7.5 , respectively), especially when the Clearfil Tri-S was used in the conventional protocol. When cured with RD or UL and not etched, Clearfil Tri-S presented the higher gap formation.

CONCLUSION: In conclusion, additional enamel etching promoted better marginal integrity for Clearfil Tri-S, showing it to be an efficient technique for Class I composite restorations. The two-step self-etch adhesive was not influenced by selective enamel etching or by the LED-curing unit.

COMMENTS: Selective enamel conditioning showed to be an effective approach to reduce gap formation in class I restorations for one-step self-etching adhesives, and prior conditioning is indicated to improve the marginal integrity of the interface. The two steps self-etching adhesive was not influenced by the selective enamel etching or the LED light curing agent. In general, the one-step self-etching adhesion system presented better performance when the enamel was previously conditioned

The sixth article was a randomized, 36-month follow-up study using universal adhesive system, with or without selective conditioning. The article was published in the Journal of Dentistry in the year 2015.

A NEW UNIVERSAL SIMPLIFIED ADHESIVE: 36-MONTH RANDOMIZED DOUBLE-BLIND CLINICAL TRIAL.

Loguercio AD, de Paula EA, Hass V, Luque-Martinez I, Reis A, Perdigão J.

J Dent. 2015 Sep;43(9):1083-1092.

doi: 10.1016/j.jdent.2015.07.005.

STATEMENT OF THE PROBLEM: It is still debatable which technique should be used with universal adhesives, either etch-and-rinse (wet or dry) or self-etch strategy (with or without selective enamel etching).

PURPOSE OF THE STUDY: To evaluate the 36-month clinical performance of Scotchbond Universal Adhesive (SU, 3M ESPE) in non-carious cervical lesions (NCCLs) using two evaluation criteria.

METHODS/MATERIALS: Thirty-nine patients participated in this study. Two-hundred restorations were assigned to four groups: ERm: etch-and-rinse+moist dentin; ERd: etch-and-rinse+dry dentin; Set: selective enamel etching; and SE: self-etch. The same composite resin was inserted for all restorations in up to 3 increments. The restorations were evaluated at baseline and at 6-, 18-, and 36-months using both the FDI and the USPHS criteria. Statistical analyses were performed with Friedman repeated measures ANOVA by rank and McNemar test for significance in each pair ($\alpha=0.05$).

RESULTS: Eight restorations (ERm: 1; ERd: 1; Set: 1 and SE: 5) were lost after 36 months, but only significant for SE when compared with baseline ($p=0.02$ for either criteria). Marginal staining occurred in 6.8% of the restorations (groups ERm, ERd, and Set) and 17.5% of the restorations (group SE), with significant difference for each group when compared with baseline using the FDI criteria ($p<0.04$), while statistical significance was reached only for SE when compared with baseline using the USPHS criteria ($p<0.03$). Twenty-eight and 49 restorations were scored as bravo for marginal

adaptation using the USPHS and FDI criteria, respectively, with significant difference for each group when compared with baseline ($p<0.05$).

CONCLUSIONS: While there was no statistical difference among bonding strategies when a universal adhesive was used, there were signs of degradation when the universal adhesive was applied in SE mode. The FDI criteria remain more sensitive than the USPHS criteria, especially for the criteria marginal staining and marginal adaptation.

COMMENTS: In this study, the authors evaluated through a clinical research of 36 months, different strategies and adhesion using the universal adhesive system “ScotchBond Universal” in a challenging situation, such as non-carious cervical lesions. Many clinicians still have questions about which strategy to adopt when using universal adhesives, especially on mixed substrates, for example, involving dentin and enamel. Through evaluations using the FDI and USPHS parameters, the authors showed that there was no statistically significant difference between the strategies. However, there is a consensus that total acid etching on dentin and the subsequent application of the universal adhesive (whether in wet or dry dentin) resulted in worse clinical performance of this adhesives.

The seventh article tested whether 1-step universal adhesives can be applied in a “multi-mode” manner, followed by different “total” or “selective” approaches to conditioning. The article was published in the Journal of Dentistry in the year 2012.

BONDING EFFECTIVENESS OF A NEW ‘MULTI-MODE’ ADHESIVE TO ENAMEL AND DENTINE.

Hanabusa M, Mine A, Kuboki T, Momoi Y, Van Ende A, Van Meerbeek B, De Munck J.

J Dent. 2012 Jun;40(6):475-84.

doi: 10.1016/j.jdent.2012.02.012. Epub 2012 Feb 28.

OBJECTIVES: Self-etch adhesives are well adopted in general practice, obviously primarily thanks to their ease of use and fast application time. Nevertheless, phosphoric acid is still often recommended to beforehand etch enamel following a so-called ‘selective’ enamel-etch technique, this in particular when most cavity margins end in enamel. The purpose of this study was to test if a new one-step adhesive can be applied in a multi-mode manner, this following different, either ‘full’ or ‘selective’, self-etch and etch-and-rinse approaches. Specific research hypotheses tested were that prior phosphoric-acid etching did not affect

the bonding effectiveness of the one-step adhesive to enamel and dentine, and that the bonding effectiveness to dentine was also not affected when the adhesive was applied either following a ‘dry-bonding’ or ‘wet-bonding’ etch-and-rinse technique.

METHODS: The micro-tensile bond strength (μ TBS) of the one-step self-etch adhesive G-Bond Plus (GC, Tokyo, Japan; 1-SEA) was measured when it was bonded to bur-cut enamel following either a ‘self-etch’ or an ‘etch-and-rinse’ adhesive protocol, and to bur-cut dentine when applied following either a ‘self-etch’, a ‘dry-bonding’ or a ‘wet-bonding’ etch-and-rinse adhesive protocol. Bond-strength testing was corroborated by ultra-structural analysis of the interfacial interaction at enamel and dentine using transmission electron microscopy (TEM).

RESULTS: Prior phosphoric-acid etching significantly increased the bonding effectiveness of the 1-SEA to enamel. A clearly enhanced micro-retentive surface was revealed by TEM. To dentine, no statistically significant difference in bonding effectiveness was recorded when the 1-SEA was either applied following a self-etch or both etch-and-rinse approaches. The 'dry-bonding' etch-and-rinse protocol was significantly more effective than its 'wet-bonding' version. TEM however revealed indications of low-quality hybridization following both etch-and-rinse approaches, in particular in the form of a porous and poorly resin-infiltrated collagen mesh.

CONCLUSIONS: While phosphoric-acid etching definitely improved bonding of the one-step self-etch adhesive to enamel, one should be more careful with additional phosphoric-acid etching of dentine. Although the bond strength was not reduced, the resultant

adhesive interface appeared ultra-structurally more vulnerable to biodegradation.

COMMENTS: In this *in vitro* analysis, the bond strength and the ultramorphological characteristic of a 1-step self-etching adhesive system were investigated when used in different enamel and dentin bonding strategies. The results showed that selective enamel acid etching should be performed to obtain a better bond strength of this self-etching adhesive system. However, when used in dentin the results obtained were different. Although the dentin bond strength was not significant when the bonding strategies (self-conditioning, acid etching with acid dentin and acid etching with dry dentin) were varied, in the ultra-morphological aspect it was observed that the hybrid layer of union in both dry and wet dentin techniques presented with low quality. This means that in dentin, the ideal would only be to use the adhesive self-conditioning system, without prior application of acid.

It is noteworthy that the tests were performed immediately after the adhesive procedures. If the bond strength test was performed after the specimens were aged, dentin bonding values would be different between the strategies, evidencing the negative aspect of acid etching prior to the use of a 1-step self-etching adhesive system.

The eighth study clinically evaluated two self-etching adhesive systems applied with or without selective acid etching of the enamel. The article was published in Operative Dentistry, in the year 2016.

TWO-YEAR RANDOMIZED CLINICAL TRIAL OF SELF-ETCHING ADHESIVES AND SELECTIVE ENAMEL ETCHING.

Pena CE, Rodrigues JA, Ely C, Giannini M, Reis AF.

Oper Dent. 2016 May-Jun;41(3):249-57.

doi: 10.2341/15-130-C.

OBJECTIVE: The aim of this randomized, controlled prospective clinical trial was to evaluate the clinical effectiveness of restoring noncarious cervical lesions with two self-etching adhesive systems applied with or without selective enamel etching.

METHODS: A one-step self-etching adhesive (Xeno V(+)) and a two-step self-etching system (Clearfil SE Bond) were used. The effectiveness of phosphoric acid selective etching of enamel margins was also evaluated. Fifty-six cavities were restored with each adhesive system and divided into two subgroups (n=28;

etch and non-etch). All 112 cavities were restored with the nanohybrid composite Esthet.X HD. The clinical effectiveness of restorations was recorded in terms of retention, marginal integrity, marginal staining, caries recurrence, and postoperative sensitivity after 3, 6, 12, 18, and 24 months (modified United States Public Health Service).

RESULTS: The Friedman test detected significant differences only after 18 months for marginal staining in the groups Clearfil SE non-etch (p=0.009) and Xeno V(+) etch (p=0.004). One restoration was lost during the trial (Xeno V(+) etch; p>0.05).

CONCLUSIONS: Although an increase in marginal staining was recorded for groups Clearfil SE non-etch and Xeno V(+) etch, the clinical effectiveness of restorations was considered acceptable for the single-step and two-step self-etching systems with or without selective enamel etching in this 24-month clinical trial.

COMMENTS: In this clinical, randomized, controlled and prospective research, the influence of selective phosphoric acid etching on the enamel in non-carious cervical restorations was evaluated. Using two types of adhesive self-conditioning systems, with one and two clinical steps, with or without selective acid conditioning on the enamel edges. The study showed that all strategies were effective after 24 months. It is worth noting that dentin acid etching was not performed in this experiment, only the enamel, obtaining similar results after 24 months. Perhaps important clinical information will be published in the future clinical follow-ups of this research.

system for adhesion of resinous materials. Although in enamel studies are still not very evident, it might be interesting to maintain the strategy of a selective etching of the enamel margins, thinking about longevity of the marginal integrity of the restoration. It is also evident that the active application of these systems is fundamental to guarantee adhesion quality, as well as the use of an effective photopolymerization system to optimize polymer conversion.

After the analysis of the articles that discussed the behavior of the self-etching adhesive systems, it can be observed that the selective etching of the enamel prior to the application of the self-etching adhesive does not clinically significantly alter its behavior in terms of retention of the restoration when compared by the same adhesive system, without selective etching. However, it has been observed, that the selective conditioning of the enamel margins, can improve the integrity and marginal discoloration of the restorations. In addition, studies have shown that in dentin, it has been increasingly confirmed that the best adhesive strategy is solely use of the self-etching

LUCAS SILVEIRA MACHADO^{1,2}

1. Universidade Federal do Rio Grande do Sul, Faculdade de Odontologia, Departamento de Odontologia Conservadora (Porto Alegre/RS, Brazil).
2. Doctorate and Master's Degree in Dentistry, Universidade Estadual Paulista, Faculdade de Odontologia de Araçatuba (Araçatuba/SP, Brazil).

RODOLFO BRUNIERA ANCHIETA^{1,2,3}

1. Centro Universitário do Norte Paulista, Faculdade de Odontologia (São Jose do Rio Preto/SP, Brazil).
2. Universidade Estadual Paulista, Faculdade de Odontologia de Araçatuba, Departamento de Odontologia Restauradora (Araçatuba/SP, Brazil).
3. Doctorate and Master's Degree in Dental Prosthesis, Universidade Estadual Paulista, Faculdade de Odontologia de Araçatuba (Araçatuba/SP, Brazil).

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