



Adhesion-cohesion inter-phase among fiberglass posts, dual cement and dentine before irrigation with two disinfectant materials

Evaluación de la interfase de adhesión-cohesión entre el poste de fibra de vidrio, cemento dual y dentina, previa irrigación con 2 sustancias desinfectantes

Mónica Alava Freire,* Nancy Mena Córdova,§ Fernando Sandoval Vernimmen^{II}

ABSTRACT

A great number of fiber-glass post de-cementation cases after adhesion to root canal have been reported. The aim of the present study was to assess effectiveness of two disinfectant materials: 5.25% sodium hypochlorite (NaClO), and 2% Chlorhexidine used as irrigation agents before cementation of fiberglass posts (FGP) in the process of adhesion-cohesion, using dual cement (DC). Thirty teeth, endodontically treated with previously sectioned clinical crowns, were prepared to each receive a FGP. Samples were divided into three groups and different root canal irrigation techniques were used: 1. 5.25% NaClO, 2. 2% Chlorhexidine, and 3. Water. Samples were transversely sectioned with diamond disc at the cervical third (CT) and at the middle third (MT), thus, 60 study samples were obtained. Observation and measurement of dual cement/dentin (DC/D) and dual cement/post (DC/P) were conducted with scanning electron microscope. These measurements were taken at MT and CT. Gaps present at the DC/D and DC/P on surfaces free of adhesion-cohesion were also measured. Data analysis revealed significant differences with respect to effectiveness with adhesion percentages in DC/D dentine when using 5.25% NaClO technique versus 2% Chlorhexidine and water techniques. There was no observed significant difference in mean adhesion percentages in CT and MT. 5.25% NaClO irrigation technique proved to be the one causing less DC/D and DC/P interference. It showed higher adhesion percentage both in DC/D inter-phase and DC/P cohesion inter-phase.

RESUMEN

Se han reportado un gran número de casos de des cementación de postes de fibra de vidrio luego de su adhesión al conducto radicular. El propósito de este estudio fue evaluar la eficacia de dos sustancias desinfectantes como el hipoclorito de sodio (NaClO) 5.25%, y la clorhexidina 2% utilizadas como irrigantes antes de la cementación del poste de fibra de vidrio (PFV) en el proceso de adhesión-cohesión, usando cemento dual (CD). Treinta dientes endodonciados, seccionados previamente en sus coronas clínicas, fueron preparados para recibir cada uno un PFV. Los cuerpos de prueba fueron divididos en tres grupos y se utilizó una técnica diferente de irrigación del conducto radicular: 1. NaClO al 5.25%, 2. Clorhexidina al 2%, y 3. Agua. Los especímenes, fueron seccionados transversalmente con un disco de diamante en el tercio cervical (TC) y en el tercio medio (TM), obteniéndose 60 muestras para el estudio. Se realizó la observación y medición al microscopio electrónico de barrido (MEB) de las interfaces cemento dual/dentina (CD/D) y cemento dual/poste (CD/P), tanto en su TM como en su TC, así como la medición del espacio existente en las interfaces CD/D y CD/P de la superficie sin adhesión-cohesión. El análisis de datos reveló una significancia en cuanto a la eficacia en relación al porcentaje de adhesión en la interfase CD/D usando NaClO al 5.25% en relación a la clorhexidina al 2% y agua. No existiendo diferencia significativa en el promedio del porcentaje de adhesión en el TC y en el TM. La técnica de irrigación con NaClO al 5.25% demostró ser la que menor interferencia produjo en la interfase CD/D y CD/P presentando el mayor porcentaje de adhesión tanto en la interfase CD/D y cohesión en la interfase CD/P.

Key words: Fiberglass post, 2% chlorhexidine, 5.25% sodium hypochlorite, adhesion, scanning electron microscope (SEM).

Palabras clave: Postes de fibra de vidrio, clorhexidina 2%, hipoclorito de sodio 5.25%, adhesión, microscopio electrónico de barrido.

INTRODUCTION

Scientific research with respect to restorative materials and procedures in teeth having received root canal treatment, and its corresponding technological progress, have enabled teeth to remain longer in the mouth and thus favored masticatory function and esthetics.¹ Presently, there are two types

* Student, Oral Prosthetic Specialty.

§ Coordinator, Oral Prosthetics Specialty.

^{II} Dean, School of Dentistry.

San Francisco de Quito University (USFQ)

This article can be read in its full version in the following page:
<http://www.medigraphic.com/facultadodontologiaunam>

of endodontic posts in the market: pre-fabricated or individualized posts. Many dentists prefer using pre-fabricated posts since they consider them more practical,² less expensive, and in some cases, less aggressive to dental tissues when compared to cast posts and stumps. The function of the post, besides retaining a segment of the crown, is to prevent fractures in the endodontically treated tooth, providing it with internal resistance and support. This objective is mainly met with non-metallic, pre-fabricated, esthetic adhesive posts, manufactured with glass fibers or quartz.³ Placement of FGP has been well established in stump retention elasticity module, where we see a significant decrease in risk of root fractures. When adopting this procedure, operative time is reduced, and thus, time and cost are optimized and restoration prognosis is more favorable.⁴ Recent introduction of materials able to create dentine adhesion has provided a viable alternative to reconstruct and rehabilitate teeth severely damaged by caries, traumas, or congenital (hereditary) deficiencies.⁴

Complete removal of dentinal debris is an essential requirement⁵ for successful prognosis of root-adhesion therapy. This is due to the fact that dentinal debris contain microorganisms as well as infected, deteriorated dentine. There are successful methods to remove dentinal debris.³ Effect of endodontic irrigation at the junction between resin cement to root dentin depends on the dentin adhesive system used.⁵ Demineralization and de-proteinization processes favor penetration of resinous tags into dentin tubules, and contribute to produce high bonding strength. When using self-etching adhesive systems, excessive demineralization caused by endodontic irrigant agents should be avoided.²

Adhesion procedure of the post inside root canal consist on applying 5.25%NaClO for 30 to 60 seconds, after this period, orthophosphoric acid is applied. The area is then cleansed with water to eliminate collagen fibers previously released from the hydroxyapatite due to the action of the phosphoric acid.⁶ These collagen fibers could possibly collapse when excessive dentin dissecation occurs.³ Notwithstanding all these facts, due to the scarce amount of conducted research in that subject, there is no established protocol for FGP placement at the moment of free canal irrigation. The aim of the present study is to assess SEM repercussion in adhesive processes.

METHODS

The sample was composed of 30 single- rooted or bi-rooted teeth, donated by orthodontists. Teeth

were previously cleansed and x-rayed, to assess whether they were free of caries, fissures, fractures or root calcifications. Teeth were stored in 9% isotonic saline solution and refrigerated until they were used.

Crowns were sectioned at cervical level, using diamond disc (Diatech, Coltene/Whaledent) and Kavo micro-engine (Brasil). Specialized endodontists at the SFQU graduate school performed root canal treatment. Teeth were randomly divided into three test groups, 10 teeth to a group. Periapical x-rays were taken to ascertain canal measurements. A rubber stopper was placed at a Gates Glidden number 2 burr (Dentsply, Maillefer). Freeing of the canal was undertaken with low speed hand-piece;^{7,8} intermittent movements were used to achieve this aim. Treatment was continued with peeso burr number 2 (Dentsply, Maillefer). Finally, Fiber Kleer Post System (Pentron Clinical) post system red burr was used, and the FGP was individually adjusted to conform to each canal anatomy.

FGP were cleansed with a gauze previously soaked in alcohol (72° ethanol) during 15 seconds to remove any grease-contaminated substance which might be present in the posts. Posts were dried and a silane layer was applied for 1 minute.³ Canals of sample teeth were irrigated according to group with the following: 1) 5.25% NaClO for 15 seconds (Quimical), 2) 2% Clorhexidine for 15 seconds (Consepsis- Ultradent) and 3) water from the dental unit for 15 seconds. Canals were dried with number 40 paper cones, 37% orthophosphoric acid was applied (Ivocalr-Vivadent) for 15 seconds. After this, teeth were cleansed with triple syringe with water, and dried anew with number 40 paper cones.^{7,8} Excite DSC (Ivoclar, Vivadent) adhesive system was placed with applicators, to cover all canal walls, rubbing for 10 seconds within the root canal. Adhesive excesses were removed with air stream during one to three seconds at 5 mm distance from the preparation surface. A sterile file was used to assess permeability within the canal. Polymerization was conducted with Optilux lamp 501 (Kerr) at ramp inclination during 20 seconds. Dual cement (Duo Link Brisco) placed in the dispensing tips was injected into the root canal of each sample with the help of a lentulus. (Dentsply, Maillefer) to homogeneously distribute cement.⁹ After assessing correct position, the post was placed into the canal and was polymerized for 60 seconds. In all 30 teeth, two cuts were performed with micro-engine and diamond burr (Diatech/Coltene Whaledent) at MT and CT. This provided 60 samples, 20 to every

group. Samples were stored in a refrigerated, sterile metal box. All surfaces to be observed, at MT and CT were identified.

Samples were polished with number 1200 and number 1500 water sandpaper. After this, samples were cleansed with alcohol (72° ethanol) and dried with absorbent paper. Once they were properly identified, test samples were subjected to dehydration with ethanol and acetone.¹⁰ Drying was achieved through freezing, to decrease sample distortion which might have occurred during water evaporation. A thin layer of gold was applied to the samples so as to enable observation with SEM¹¹ at 500x, 1500x, 2000x, 3500x, and up to 5000x augmentations. Three images of DC/D and DC/P interphase were obtained for each test sample so as to establish adhesion-cohesion boundaries (A/C) limits in both inter-phases. Measurements were conducted using SEM software at angles of inter-phase DC/D and DC/P taken from a central point of the FGP. Total adhered surface between both cases of DC/D and DC/P and at CT and MT were taken as a parameter. The observed total central contact angle α , measured in degrees, in each sectioned areas between DC/P and between DC/D, provided the A/C measure present in the section. Alfa calculation was used to obtain adhesion-cohesion percentage. To calculate α the sum of all central partial angles was considered, α_i , that is to say, $\alpha = \sum_{i=1}^n \alpha_i$. The greater sum of A/C angles from each group provides the efficiency relationship of substances used, in this case, the efficiency of 5.25% NaClO (Figure 1).

RESULTS

Small fissures (cracks) were observed at DC/D when water was used as irrigating agent (Figure 2). This same gap was significantly observed when using 2% Chlorhexidine as irrigating solution (Figure 3). Nevertheless, when using 5.25% NaClO, no gap was observed, therefore we can affirm there was excellent adhesion between dual cement and dentine (Figure 4).

Therefore, in average, use of 5.25% NaClO as root disinfectant is more adhesion-efficient than 2% Chlorhexidine and than Water. 2% Chlorhexidine is less effective than water at the DC/D inter-phase. Therefore, there is an even greater effectiveness difference between 5.25% NaClO and Water.

It also becomes evident that at the DC/P interphase, cohesion percentages are greater than adhesion percentages at the DC/D inter-phase. As far as cohesion goes, there is no significant difference

among all three substances. In all thirds there was favorable bonding at the DC/P inter-phase (Figures 5, 6 and 7).

DISCUSSION

Goldsmith¹² showed that, when preparing dentin, a detritus layer is produced. This layer must be either treated or removed before proceeding with application of adhesives. This must be achieved so as to increase free superficial energy and provide receptiveness in the bonding mechanism.^{13,14} In this study, 37% orthophosphoric acid was employed. This acid de-mineralized dentin surface and removed the detritus layer present as well as 5.25% NaClO, which de-proteinized collagen fibers, at some point even removing them, which enhanced permeability. Schwartz showed that the formation of a somewhat water proof amorphous gel over the upper section of the collagen structure, has been attributed to the combined effect of de-naturalization and collagen residual detritus layer collapse which could prevent total penetration of resin material. To remove this gel, it has been suggested to briefly apply a 5.25% NaClO solution.^{4,3} In the present study, application of 5.25% NaClO solution eliminated the debris layer formed by de-naturalized collagen fibers, dentin residues as well as other detritus. Dentin of an endodontically treated tooth is a substratum rendering adhesion less than perfect. This is due to the fact that, due to decreases in tissue relative humidity, collagen fibers are found at different degrees of de-naturalization and micro-fracture.^{3,4,14} In the present study, root dentin was prepared with instru-

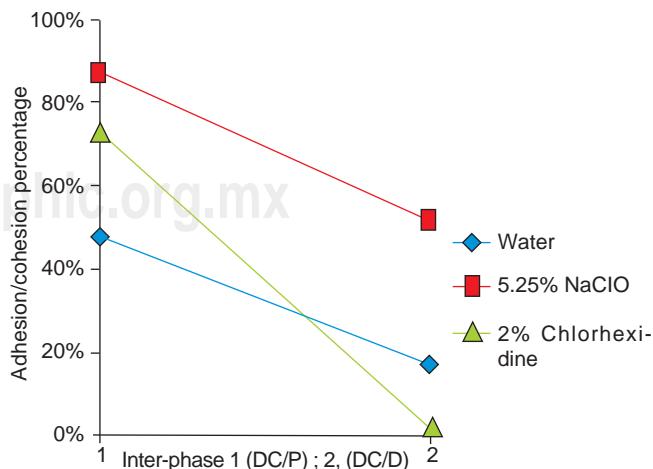


Figure 1. Interphase 1 (DC/P); 2, (DC/D).

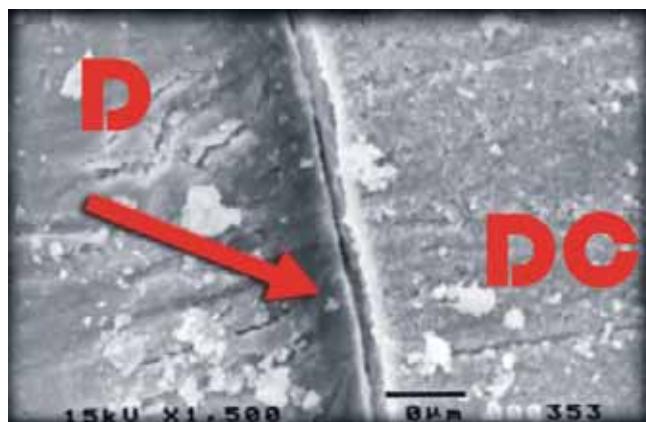


Figure 2. Inter-phase. DC/D adhesion. Water.

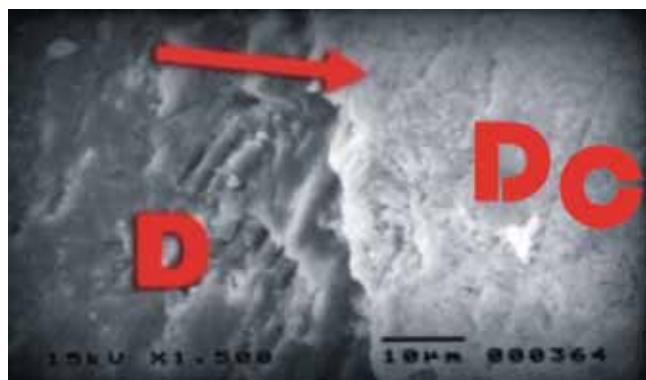


Figure 3. Inter-phase. DC/D adhesion. 2% Chlorhexidine.

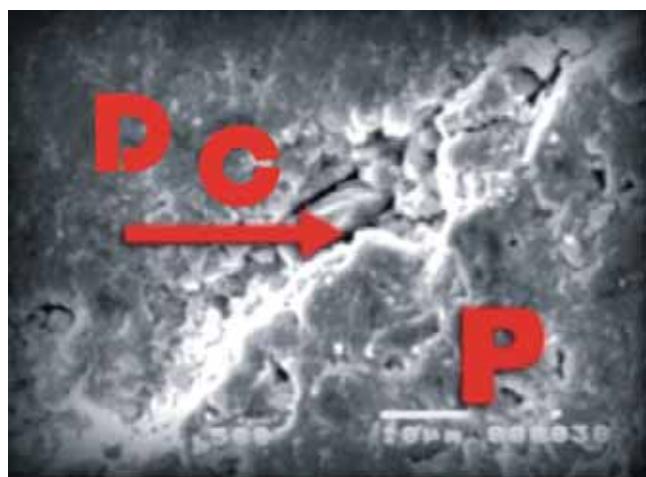


Figure 4. Inter-phase. DC/D adhesion. 5.25% NaClO.

ment use and de-obturation with gutta-percha. This process contributed to modifying even more dentin structure. This leads us to suggest that the use of a material to remove all these debris is essential. When 5.25% NaClO is used in final irrigation, the structure of dentinal tubules significantly alters, in such a way that removal of dentin debris enhances maintenance of permeability in non-contaminated dentinal tubules.^{4,15} In the present study, according to obtained adhesion-cohesion results, application of 5.25% NaClO did remove dentin debris in studied samples, favoring thus contamination-free dentin permeability.¹⁶

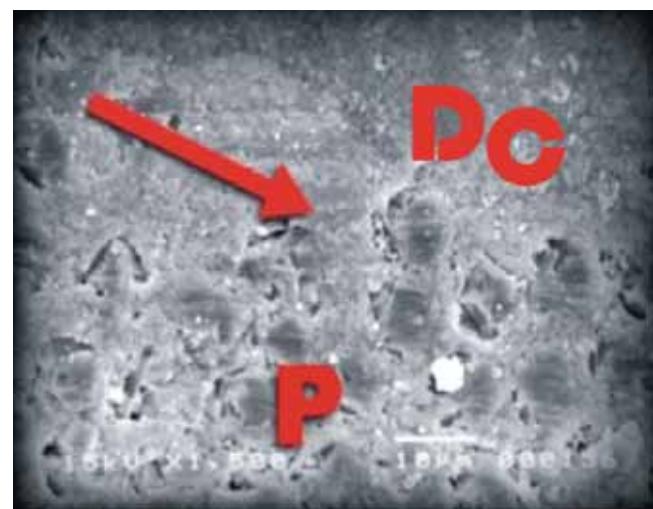


Figure 5. Inter-phase. DC/P cohesion. Water.

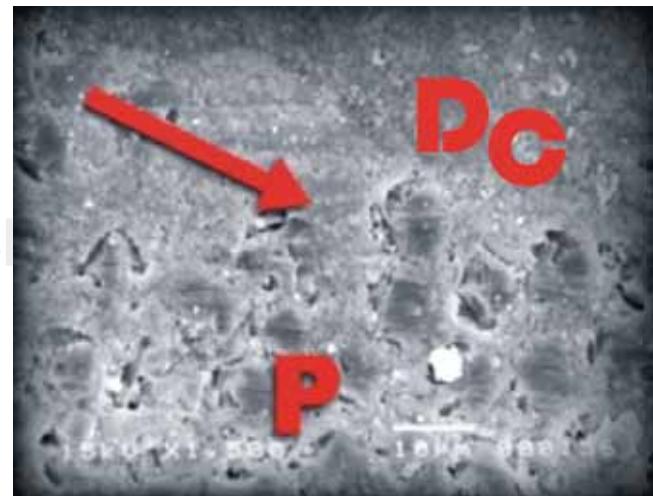


Figure 6. Inter-phase . DC/P cohesion. 2% Chlorhexidine.

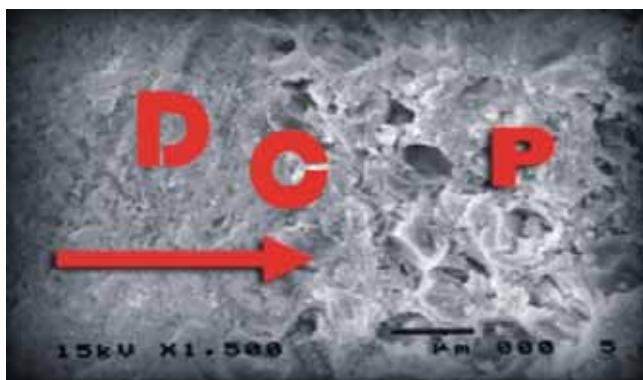


Figure 7. Inter-phase. DC/P cohesion. 5.25% NaClO.

Ferran⁴ states that dentin located at the cervical third possesses great permeability, rendering thus this region more susceptible to the action of chemical materials used to prepare root canals. 5.25% NaClO regularly enhanced retention at the two thirds and two DC/D and DC/P inter-phases. Research conducted by Lopez P Celis¹⁷ state that 2% Chlorhexidine and 5.25% NaClO solutions, decrease retention of FGP, as well as their resistance to displacement. It was also stated that application within the canals of 2% Chlorhexidine enhances greater adhesion of cements to resin bases than when using 5.25%. In the present study, it became evident that there was decreased adhesion at the DC/D when using as root disinfectant 2% chlorhexidine when compared to adhesion efficiency of DC/D when using 5% NaClO. Henoztroza³ informed that, 5% NaClO application time increase resulted in a progressive bonding decrease. In this study, 5.25% NaClO irrigation was performed during 15 seconds; this showed greater effectiveness in DC/D inter-phase adhesive resistance at both thirds. This effect was probably due to the removal of collagen fibers from the de-mineralized zone. This equally suggests that adhesive force is associated with the amount of existent collagen present in the superficial dentin layer.¹⁸ This study confirms that when compared to 2% Chlorhexidine and Water, 5.25% NaClO is the material that best eliminated de-naturalized collagen fibers. Nevertheless, in an ideal situation this removal would reach 100%. This remains a challenge for future research.

CONCLUSIONS

According to the conditions in which this study was conducted, we beg to conclude that:

1. When studying with SEM, there was no significant adhesion difference in all three materials used when assessing MT and CT inter-phases.
2. 5.25% NaClO showed best adhesion of DC/D and DC/P inter-phase in both examined thirds.
3. In DC/D inter-phase, adhesion values were lowest when using 2% Chlorhexidine.
4. When using Water at the DC/D inter-phase, adhesion values were better than when using 2% Chlorhexidine.
5. When using 2% Chlorhexidine, cohesion values at the DC/P inter-phase were slightly lesser than when using 5.25% NaClO, and higher to those observed when using Water. Nevertheless, there is no statistically significant difference and cohesion at DC/P inter-phase was paramount.

REFERENCES

1. Aksornmuang J, Nakajima M, Foxton R, Tagami J. Mechanical properties and bond strength of dual-cure resin composites to root canal dentin. *Dent materi* 2006; 12: 332-36.
2. Jiménez M, Mantellini G. *Restauración de dientes tratados endodónticamente con muñones de resina reforzada con fibras de vidrio*. Caso Clínico, Universidad Central de Venezuela, Departamento de Cariología, Ciencias Restauradoras y Endodónticas University of Michigan-Escuela de Odontología, Michigan.
3. Henoztroza G. *Adhesión en Odontología Restauradora*. Interamericana 2010.
4. Scotti R, Ferrari M. *Pernos de fibra bases teóricas y aplicaciones clínicas*, Edit. Masson 2003.
5. Hayashi, Y, Maki. Effect of endodontic irrigation on bonding of resin cement to radicular dentin. *J Oral Rehab* 2005, (113):70-76.
6. Mallat, Callis E. *Prótesis fija estética. Un enfoque clínico interdisciplinario*. 2007.
7. Muniz L, Mathias P. The influence of sodium hypochlorite and root canal sealers on post retention in different dentin regions. *Oper. Dentist* 2005; (30)-4. 533-539.
8. Muniz L. La Importancia de la selección del perno para una mejor estabilidad y longevidad de la prótesis nuevos conceptos y materiales; Caso clínico *Revista FGM Brasil* 2006; (2): 36-43.
9. Faieta L. Comparación de tres técnicas de colocación del agente cementante resinoso durante la inserción de un poste de polímero reforzado con fibra de vidrio. Tesis presentada en la FO. USFQ. Junio 2007.
10. ESPE. *Catálogos MEB Departamento Ciencias de la vida* 2000.
11. Amano Y. *Introducción a la microscopía electrónica principios-aplicaciones* 2004: 5-10.
12. Goldsmith M, Kishor MG. The effect of sodium hypochlorite irrigant concentration on tooth surface strain. *J Endod* 2005; (28): 48-53.
13. Coelho G, El-Mowafy O, Hernique J. Diametral tensile strength of a resin composite core with nonmetallic prefabricated posts: An *in vitro* study. *J Prosth Dentist* 2004; 91: 335-41.
14. Schwartz R. *Fundamentos de Odontología Operatoria* 2000: 141-173.
15. Pfeiffer P, Schulz A, Nergiz I, Schmage P. Strength of zirconia and glass fibre-reinforced posts. *J Oral Rehab* 2006; (33): 70-45.
16. Goldsmith, Glabivala. The Effect of sodium hypochlorite irrigant concentration on tooth surface strain. *J Endod* 2002; (28): 575-579.

17. López P, Celis L, Guerrero J. Influencia de la desinfección de conductos radiculares con clorhexidina al 2.0% en la resistencia al desalojo de postes de fibra de vidrio colocados con cementos a base de resina (estudio *in vitro*). *Tesis presentada en la Universidad Nacional autónoma de México*, Septiembre 2005.
18. Wakabayashi, Yasuhiro. Effect of dissolution of collage non adhesion to dentin, tahe international. *J Prosth* 1994; (7): 4, 56-62.

Mailing address:

Dra. Nancy Mena.
E-mail: ncmc10@hotmail.com

Dr. Fernando Sandoval V
E-mail: drfernandos@hotmail.com