The Effect of Luting Agents on the Retention of Dental Implant-Supported Crowns

Yu-Hwa Pan, DDS, MS; Ching-Kai Lin, DDS

Background: This study was designed to evaluate the retentive strength of 7 different luting agents on cement-retained implant abutment/analog assemblies.

Methods: Fifty-six Steri-Oss implant abutment/analog assemblies and cast superstructures were randomly divided into 7 groups: definitive cements included zinc phosphate cement, Advance, All-Bond 2, Panavia F, and Durelon, while provisional cements included Temp Bond and ImProv. After the superstructures were cemented onto the implant abutments, the specimens were subjected to 100,000 cycles on a chewing machine (75 N) and 1000 cycles on a thermocycling machine (0~55°C). A universal testing machine was used to test the cement failure load values for each specimen. One-way ANOVA and Duncan's multiple-range analysis were used to determine the effects of luting agents on cement failure load values.

Results: The following values for the mean and standard deviation of cement failure loads for each group were obtained: zinc phosphate, 1.225 ± 0.229 MPa; Advance, 1.205 ± 0.197 MPa; All Bond 2, 1.752 ± 0.211 MPa; Panavia F, 1.679 ± 0.176 MPa; Durelon, 0.535 ± 0.161 MPa; Temp Bond, 0.274 ± 0.079 MPa; and ImProv, 0.319 ± 0.107 MPa.

Conclusions: There were significant differences in cement failure loads among the various cements tested. Values significantly differed among 4 groups consisting of All-Bond 2 and Panavia F resin cements, zinc phosphate cement and Advance hybrid ionomer cement, Durelon carboxylate cement, and ImProv and Temp Bond provisional cements ($p < 0.0001$). All-Bond 2 and Panavia F resin cements had statistically significantly higher values for cement failure loads compared to the other 5 types of cement.

(Chang Gung Med J 2005;28:403-10)

Key words: implant, cement, failure.

Many current implant systems have abutments onto which superstructures can be cemented. Some dentists prefer to cement implant prostheses, whereas others like to secure them using screws. Because it is difficult to achieve a passive-fit framework for screw-retained implant restorations, cement-retained implant prostheses have become increasingly popular. However, the use of such a cemented superstructure on an implant abutment might not permit its removal for future maintenance.

From the Department of Dentistry, Chang Gung Memorial Hospital, Keelung.
Received: Mar. 10, 2005; Accepted: May 4, 2005
Address for reprints: Dr. Yu-Hwa Pan, Department of Dentistry, Chang Gung Memorial Hospital. No. 222, Maijin Rd., Anle Chiu, Keelung, Taiwan 204, R.O.C. Tel.: 886-2-24313131 ext. 2469; Fax: 886-2-24313161; E-mail: philipcklin@msn.com

Consequently, the selection of luting agents is very important for implant cement-retained fixed prostheses. Andersson et al.[1] reported that in 2 of 32 patients, the restorations failed to seat completely during cementation and had to be remade. The intimate fit of the parallel-sided hexagonal CeraOne abutment (Nobel Biocare, Goteborg, Sweden) with the machined gold cylinder provides minimal space for cement. The type of cement used is also an important consideration because it affects the retention characteristics of the restoration. It may be desirable to use a type of cement that allows the restoration to be retrieved, so that a superstructure can temporarily be cemented to evaluate the loading of the implant, occlusion, tissue response,[2] and screw loosening. Dixon et al.[3] investigated the thickness of the die spacer necessary to reduce seating discrepancies of castings cemented onto implant abutments in order to determine the effect, which this space creates for the luting agent, has on crown retention. They found that the use of die spacing (platinum foil as the spacer) decreased seating discrepancies and increased retention values under in vitro test conditions. Consequently, 0.001-inch (25-mm) platinum foil was used as a spacer between the abutment and the cast superstructure in the current study in order to follow the previous research protocol.

Kent et al.[4,5] and Koka et al.[6] evaluated the retentive strength of different luting agents on the CeraOne abutment system. They found that zinc phosphate cement produced a stronger retentive bond than either glass ionomer cement or Temp Bond. Clayton et al.[7] evaluated the retentive strength and marginal seating discrepancies of 5 luting agents on the CeraOne single-tooth implant system. They found that zinc phosphate cement produced a 164% stronger retentive bond than glass-ionomer and a 49% stronger bond than composite resin cement. Clayton et al.[7] evaluated the marginal discrepancies of 5 luting agents on the CeraOne abutment system. Scanning electron micrographs of the abutment-gold cylinder marginal opening revealed that zinc phosphate cement produced the largest opening, but its mean value might not be clinically significant. Gorodovsky et al.[8] also found by SEM analysis that the margins of the zinc phosphate cement and composite resin were almost intact, whereas the glass-ionomer cement had substantially dissolved from the margins. Consequently, the zinc phosphate luting agent (Mizzy, Cherry Hill, NJ) has been recommended in most related studies;[9-12] however, it is very difficult to retrieve zinc phosphate cement. In this study, some definitive cements, such as All-Bond 2 (resin cement, Bisco), Panavia F (resin cement, Kuraray), Advance (hybrid ionomer cement, Dentsply Caulk), and Durelon (carboxylate cement, ESPE) as well as provisional cements, such as ImProv (acrylic/urethane-based cement, Nobel Biocare Steri-Oss) and Temp Bond (zinc oxide eugenol cement, Kerr) were compared with zinc phosphate cement in order to find a cement with better retrievability but still with appropriate retention.

Zinc phosphate cement is composed of powder and liquid. The constituents of the powder are zinc oxide and magnesium oxide, and the liquid is an aqueous solution of phosphoric acid. Zinc phosphate cement is used as a definitive cement because it provides a better retentive bond for crowns.[4-7] Resin cements (All-Bond 2 and Panavia F) are considered to be highly retentive definitive cements. Acrylic/urethane-based cement (ImProv, self-curing) and zinc oxide eugenol-based cement (Temp Bond) are regarded as provisional luting agents due to the lower retentive bonds produced. The hypotheses for this study were that the retentive strengths of definitive cements (zinc phosphate cement, All-Bond 2, Panavia F, Advance, and Durelon) are higher than those of provisional cements (ImProv and Temp Bond), and that resin cements (All Bond 2 and Panavia F) are more retentive than all the other cements tested in this study.

GaRey et al.[13] identified significant retention differences among cements with load cycling, but a minimal effect on the retentive strength was demonstrated from thermocycling. What they found was that load cycling and thermocycling are critical processes to imitate the oral environment in vivo.

The purpose of this study was to evaluate the retentive strengths of 7 luting agent combinations including definitive and provisional cements on cement-retained implant abutment/analog assemblies.

METHODS

Fifty-six Steri-Oss titanium alloy 3.8-mm-diameter Hex-Lock Straight Esthetic abutments with titanium screws and implant analogs were divided into 7 different groups for this study. Mounting jigs were fabricated to house the abutment/analog assemblies and to facilitate placement within a chewing cycle machine (O'Neal, Birmingham, AL) and a universal testing machine (Instron Engineering, Canton, MA).

To provide an even thickness for the luting agent, a 0.001-inch (25-mm)-thick platinum foil was closely adapted and burnished onto the abutment surface as a die spacer (Fig. 1).[3] The abutment/analog assembly with the platinum foil in place was duplicated with silicon material (REDU-IT Duplicating Material, American Dental Supply, PA) and Microstone (Whip-Mix, KY). An 8-mm-diameter flat occlusal surface wax superstructure was built up on this stone replica. By utilizing a split-mold technique (Fig. 2) with silicone material, all 56 specimens were waxed to an identical size with an 8-mm-diameter flat occlusal surface to facilitate testing. The specimens were then sprued on the occlusal surfaces, invested with Jelenko phosphate-bonded investment, and cast with Electra (a silver palladium alloy, Ivoclar Williams, Amherst, NY) at 760°C (1400°F). The specimens were then retrieved from the casting rings, the investment materials were cleaned with a steam cleaner (Pro-Craft II Steamer Cleaner, Ivoclar North America, Amherst, NY), the casting qualities were checked, and the specimens were polished with rubber wheels. Moreover, a seating jig was fabricated with Duralay in order to mount the implant abutment/analog assembly into the mounting jig while maintaining a precise alignment. Acrylic resin was used to fix the assembly in the mounting jig (Fig. 3). A 35-Ncm torque wrench (Nobel Biocare Steri-Oss, Yorba Linda, CA) was used to tighten the abutment screws (to the torque recommended by Steri-Oss), and a urethane-based composite resin with silicon dioxide fillers (Fermit-N, Vivadent, Amherst, NY) was used to fill in the screw access openings.

Seven different luting agents were tested (Table 1). Cementation procedures involved a skilled dental assistant mixing the luting agents in a randomized

Fig. 1 Platinum foil of 0.001-in (25-μm) thickness used on the abutment surface as a die spacer.

Fig. 2 Split mold technique used to wax up the implant superstructures.

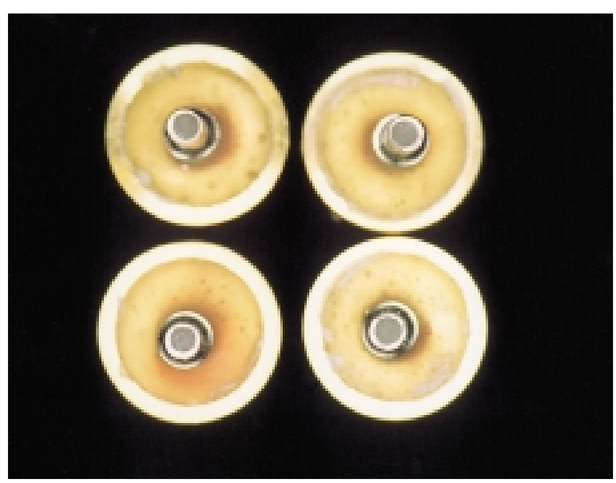

Fig. 3 Acrylic resin used to fix the abutment/analog assembly in the mounting jig.

Table 1. Seven Groups of Tested Cements

Group	Volume	Company
Definitive cement		
G1 Zinc Phosphate	1 scoop of powder and 5 drops of liquid	Mizzy Cherry Hill, NJ
G2 Advance	3 scoops of powder and 4 drops of liquid	Dentsply Caulk Milford, DE
G3 All Bond 2	6-mm length of base and accelerator	Bisco Schaumburg, IL
G4 Panavia F	6-mm length of base and accelerator	Kuraray Osaka, Japan.
G5 Durelon	1 scoop of powder and 2 drops of liquid	ESPE, Germany
Provisional cement		
Zinc oxide eugenol-based		
G6 Temp Bond	6-mm length of base and accelerator	Kerr Manufacturing Romulus, MI
Acrylic/urethane-based		
G7 ImProv	6-mm length of base and accelerator	Nobel Biocare Steri-Oss Yorba Linda, CA

order with respect to cement use by following the manufacturer's instructions. The crowns were cemented to the implant abutments (Fig. 4) and seated quickly with a 2-kg weight onto the abutments after the cementation procedures. A customized jig with an acrylic base was made to retain the 2-kg weight used to seat the crowns. A specimen loaded with the 2-kg jig was stored at 37°C in an oven with an atmosphere of 100% humidity. One hour after cementation, the 2-kg weight was removed from the oven, and the specimen was left in the oven at 37°C and 100% humidity for another 23 h.

All specimens were subjected to 100,000 cycles (with stainless-steel metal styli) at 1.2 Hz in the chewing machine with a force of 75 N which is equal to a 3-year chewing cycle in vivo.[14] Specimens then were subjected to 1000 temperature cycles of between 5 and 55°C with a 1-min dwell time in water baths (each side for 30 s).

Fig. 4 Superstructures cemented onto the abutments.

Uniaxial tensile force was applied to the abutment/crown complexes by a swivel hook, which was attached to the upper member of the universal testing machine. Another customized jig with a loop and 3 side screws was fabricated to retain the cast superstructure. The universal testing machine was hooked to the loop of the customized jig (which retained the abutment/crown complexes) to test the cement failure loads (in a randomized order with respect to cement use) using a 0.05-inch/min (0.125 cm/min) cross-head speed (Fig. 5).

One-way ANOVA was used to determine the

Fig. 5 Test jig with 3 side screws attached to the universal testing machine to test the cement failure load.

effect of luting agents on the cement failure loads. Duncan's multiple-range analysis was used to identify differences between group means of cement failure loads.

RESULTS

The tensile forces required to pull the superstructures from the abutments are presented in Table 2. Table 3 shows the sample size, means, standard deviations, minimums, and maximums of the cement failure loads for the different cements.

There were significant differences in cement failure loads among the various cements tested. Values significantly differed among 4 groups consisting of All-Bond 2 and Panavia F resin cements, zinc phosphate cement and Advance hybrid ionomer cement, Durelon carboxylate cement, and ImProv and Temp Bond provisional cements. All-Bond 2 resin cement and Panavia F had statistically significantly higher cement failure load values compared to the other 5 groups of cements (Table 3), with All-Bond 2 resin cement having the highest cement failure load and Panavia F resin cement having the next highest cement failure load, although there was not a significant difference between them. There was no significant difference between values for zinc phosphate cement and Advance hybrid ionomer cement. Moreover, there was also no significant difference between the provisional cements (ImProv and Temp Bond) (Table 3). Temp Bond had the lowest cement failure load mean among the 7 groups (Table 3), although there was no significant difference between it and ImProv.

DISCUSSION

From this study, the definitive cements (zinc phosphate cement, Advance, All-Bond 2, Panavia F, and Durelon) showed much higher retention than the provisional cements (ImProv and Temp Bond) which verified our hypothesis. All-Bond 2 resin cement and Panavia F resin cement were found to be much more retentive than zinc phosphate cement, Advance hybrid ionomer cement, Durelon carboxylate cement, ImProv, and Temp Bond which also verified our hypothesis. However, there was no significant difference in cement failure loads between zinc phos-

Table 2. Cement Failure Load Values of the Cements (MPa)

Group		S1	S2	S3	S4	S5	S6	S7	S8
G1	ZPC	1.419	1.153	1.019	0.821	1.375	1.286	1.529	1.197
G2	Advance	1.085	1.286	1.419	1.019	1.242	1.507	0.931	1.153
G3	All-Bond 2	1.441	1.973	2.039	1.618	1.862	1.529	1.729	1.818
G4	Panavia F	1.596	1.774	1.951	1.485	1.419	1.818	1.729	1.663
G5	Durelon	0.354	0.621	0.532	0.421	0.709	0.754	0.576	0.311
G6	Temp Bond	0.266	0.221	0.354	0.177	0.399	0.199	0.332	0.243
G7	ImProv	0.310	0.199	0.376	0.155	0.421	0.465	0.266	0.354

Abbreviations: ZPC: zinc phosphate cement; S1: sample 1; S2: sample 2; G1: group 1; G2: group 2; etc.

Table 3. Cement Failure Load (CFL) Values of Each Cement (MPa)

CFL	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
	ZPC	Advance	All-Bond 2	Panavia F	Durelon	Temp Bond	ImProv
SS	8	8	8	8	8	8	8
Mean	1.225[b]	1.205[b]	1.752[a]	1.679[a]	0.535[c]	0.274[d]	0.319[d]
(SD)	(0.229)	(0.197)	(0.211)	(0.176)	(0.161)	(0.079)	(0.107)
Min.	0.821	0.931	1.441	1.419	0.311	0.177	0.155
Max.	1.529	1.507	2.039	1.951	0.754	0.399	0.465

Abbreviations: SS: sample size; SD: standard deviation; Min.: minimum; Max.: maximum.
$F_{(6, 49)\ a/2} = 102.88$; $p < 0.0001$; $R^2 = 92.6\%$.
Means with different superscript letters (a, b, c, or d) statistically significantly differ from each other (by Duncan's multiple range test).

phate cement and Advance hybrid ionomer cement. There was also no significant difference between values for ImProv and Temp Bond. From the results of the present study, it was determined that definitive luting agents of zinc phosphate cement and resin cement should be selected for planned cementation of definitive fixed prostheses without possible retrieval, while provisional luting agents such as eugenol-based and resin-based provisional cements should be used for provisional cementation with possible retrieval for maintenance in, for example, a implant-supported fixed prosthesis.

The Steri-Oss Esthetic abutment which was used in this study has the unique characteristic that the facial margin is lower than the lingual margin in an attempt to achieve enhanced esthetic results. The reason that we chose this abutment system for this in vitro study was that this design helps resist rotational torque when the universal testing machine is used to pull on the superstructures until cement failure occurs. Consequently, the cement failure load values in this study were relatively consistent within each group.

Dixon et al.[3] used 0.001- (25-), 0.002- (50-), and 0.003-in (75-µm) platinum foil as die spacing for premanufactured titanium abutments to test implant-supported crown retention. They used 1 layer of platinum foil on the occlusal surface and on the axial surfaces of the abutments as the die spacing. The technique used in that study produced a uniform luting agent space between the entire casting/abutment interface. We also used 0.001-inch (25-mm) thickness platinum foil as the die spacer in this study, and burnished the foil onto the occlusal as well as onto all of the axial surfaces of the implant abutments. Use of the luting agent space between the superstructure and abutment did not decrease the retentive strength and may potentially have allowed the luting agent to act as a shock absorber for occlusal forces. It apparently worked well because the cement failure load values for each group were evenly distributed.

Koka et al.[6] concluded that significantly higher cement failure load values were produced when the access openings to the gold screw in the abutment were filled compared to when they were not filled. Data from Koka et al.'s[6] pilot investigation suggested that filling the access openings in the CeraOne system is more important in terms of retention than the choice of a definitive or a provisional cement. Temp Bond Noneugenol with a filled access opening provided greater retention than zinc phosphate with an unfilled access opening. Because of these findings, Fermit-N (Vivadent) was used to fill the access screw openings before the cementation procedures were carried out in this study.

Breeding et al.[2] also compared 3 provisional luting agents (Life, Kerr, Romulus, MI, containing calcium hydroxide; IRM, Caulk Div. Dentsply, Milford, DE, containing reinforced zinc oxide eugenol; and Temp Bond, Kerr, containing zinc oxide eugenol), a glass-ionomer cement (Ketac Cem, ESPE Premier, Norristown, PA), and 2 resin luting agents (Resiment, Septodent, New Castle, DE; and Core Paste, Den-Mat, Santa Maria, CA). They found that the 3 provisional cements (Life, IRM, and Temp Bond) were less retentive than the glass-ionomer and 2 resin luting agents (Core Paste and Resiment). These findings matched the results of the present study, which demonstrated that the provisional cements (ImProv and Temp Bond) were much less retentive than the All-Bond 2 and Panavia F resin cements, the Advance hybrid ionomer cement, and the zinc phosphate cement. Breeding et al.'s and our studies differ in that specimens in the present study were subjected to simulated chewing cycles followed by thermocycling after cementation. Moreover, Breeding et al.[2] also found that Temp Bond had the lowest cement failure load among the 3 provisional cements they tested, which matched results of this study. However, there was no significant difference in cement failure load values between ImProv and Temp Bond in this study. Breeding et al.[6] also concluded that superstructures provisionally cemented with Temp Bond, IRM, or Life provisional luting agents may be removed from implant abutments without disturbing the abutment/fixture or implant bond. Our study is in agreement with others[16-20] who showed that the retentive strengths of the provisional cements are lower than those of the definitive cements. Nevertheless, weakness of the retentive strength could serve other purposes. For example, the lower strength of the provisional cements would facilitate retrieval of the prosthesis whenever it was needed and the cleaning of cement remaining on it without damaging the abutment surface. Furthermore, clinically we learned that provisional cements, such as ImProv, were quite capable of retaining the implant-supported prosthesis for cementation. It was much easier to clean around the margin of the prosthesis after cementation of the acrylic/urethane-based provisional cement (ImProv) than the zinc oxide eugenol-based provisional cement (Temp Bond) clinically, which makes it a superior selection compared to the eugenol-type provisional cement.

Clayton et al.[7] found that zinc phosphate cement produced a stronger retentive bond than did either glass-ionomer or composite resin cements. Racher et al.[15] found that resin cement demonstrated the highest mean retentive strength when compared to zinc phosphate cement and resin-reinforced ionomer cement. In this study, All-Bond 2 resin cement and Panavia F resin cement showed greater retention than the zinc phosphate cement which coincided with results of Racher et al.[15] and others' studies.[16-20] Resin cements are still regarded as the strongest luting agents among available cements.

Acknowledgements

The authors would like to thank William R. Lacefield and Leonard A. Mueninghoff of the University of Alabama at Birmingham, AL for clinical and technical assistance, Nobel Biocare Steri-Oss for providing implant components, and Ivoclar Williams for providing the supporting alloys.

REFERENCES

1. Andersson B, Odman P, Carlsson L, Branemark P I. A new Branemark single tooth abutment: handling and early clinical experiences. Int J Oral Maxillofac Implants 1992;7:105-11.
2. Breeding L, Dixon D, Bogacki M, Tietge J. Use of luting agents with an implant system: Part I. J Prosthet Dent 1992;68:737-41.
3. Dixon D, Breeding L, Lily K. Use of luting agents with an implant system: Part II. J Prosthet Dent 1992;68:885-90.
4. Kent DK, Koka S, Froeschle ML. Retention of cemented implant-supported restorations. J Prosthodont 1997;5:193-6.
5. Kent DK, Koka S, Banks SB. Factors influencing retention of a CeraOne gold cylinder. Implant Dent 1996;5:96-9.
6. Koka S, Ewoldsen NO, Dana CL, Beatty MW. The effect of cementing agent and technique on the retention of a CeraOne gold cylinder: a pilot study. Implant Dent 1995;4:32-5.
7. Clayton GH, Driscoll CF, Hondrum SO. The effect of luting agents on the retention of the CeraOne implant system. Int J Oral Maxillofac Implants 1997;12:660-5.
8. Gorodovsky L, Sergio E, Zidan O. Retentive strength, disintegration, and marginal quality of luting cements. J Prosthet Dent 1992;68:269-74.
9. Gross M, Abramovich I, Weiss EI. Microleakage at the abutment-implant interface of osseointegrated implants: a comparative study. Int J Oral Maxillofac Implants 1999;14:94-100.
10. Rossomando KJ, Wendt SL Jr. Thermocycling and dwell times in microleakage evaluation for bonded restorations. Dent Mater 1995;11:47-51.
11. Wendt SL, Mclnnes PM, Dickinson GL. The effect of thermocycling in microleakage analysis. Dent Mater 1992;8:181-4.
12. Tani Y, Buonocore MG. Marginal leakage and penetration of basic fuchsin dye in anterior restorative materials. Dent Mater 1991;6:201-8.
13. GaRey DJ, Tjan AH, James, RA, Caputo AA. Effects of thermocycling, load- cycling, and blood contamination on cemented implant abutments. J Prosthet Dent 1994;71:124-32.
14. Suzuki S, Leinfelder KF. Localized wear and marginal integrity of posterior resin composites. Am J Dent 1999;6:199-203.
15. Racher SS, Agar JR, Duncan JP, Taylor TD. Retentiveness of dental cements used with metallic implant components. Int J Oral Maxillofac Implants 2001;16:793-8.
16. Akashia AE, Francischone CE, Tokutsune E, da Silva W Jr. Effects of different types of temporary cements on the tensile strength and marginal adaptation of crowns on implants. J Adhes Dent 2002;4:309-15.
17. Ernst C, Wenzl N, Stender E, Willershausen B. Retentive strengths of cast gold crowns using glass ionomer, copolymer, or resin cement. J Prosthet Dent 1998;79:472-6.
18. Tjan A, Li T. Seating and retention of complete crowns with a new adhesive resin cement. J Prosthet Dent 1992;67:478-84.
19. Diaz-Arnold A, Vargas M, Haselton D. Current status of luting agents for fixed prosthodontics. J Prosthet Dent 1999;81:135-41.
20. Imbery T, Burgess J, Naylor W. Tensile strength of three luting agents following two alloy surface treatments. Int J Prosthodont 1992;5:59-67.

應用於牙科植體支持性牙套之黏合劑其固位力強度之比較

潘裕華 林敬凱

背 景：此實驗旨研究 7 種不同的黏合劑應用於牙科植體支持性牙套其固位力強度之評估與比較。

方 法：56 個鑄造好的牙套由 7 組不同的黏合劑來黏著於 56 根植體支臺牙柱上。7組不同的黏合劑其中包括磷酸鋅黏合劑、樹脂黏合劑、樹脂加強型玻璃離子體黏合劑、聚羧酸鹽黏合劑、氧化鋅丁香油酚基底臨時性黏合劑、及丙烯酸酯臨時性黏合劑等。在應用咬合模擬機及溫度轉換機來模仿口腔環境及溫度後再測試黏合劑固位力之強度。One-Way ANOVA 及 Duncan’s Multiple Range Analysis 用來評估與比較各黏合劑之固位力。

結 果：每一組黏合劑固位力強度的平均值及標準差分別爲：磷酸鋅黏合劑 (Zinc phosphate)：1.225 MPa (0.229)；樹脂加強型玻璃離子體黏合劑 (Advance)：1.205 MPa (0.197)；樹脂黏合劑 (All Bond 2)：1.752 MPa (0.211)；樹脂黏合劑 (Panavia F)：1.679MPa (0.176)；聚羧酸鹽黏合劑 (Durelon)：0.535 MPa (0.161)；氧化鋅丁香油酚基底臨時性黏合劑 (Temp Bond)：0.274 MPa (0.079)；和丙烯酸酯臨時性黏合劑 (ImProv)：0.319 MPa (0.107)。

結 論：樹脂黏合劑相較於其他具有最強的固位力而永久性黏合劑的固位力都比臨時性黏合劑要強。氧化鋅丁香油酚基底臨時性黏合劑具有最弱的固位力，即使它與丙烯酸酯臨時性黏合劑在統計上沒有顯著性的差異。

(長庚醫誌 2005;28:403-10)

關鍵字：植體支臺牙柱，固位力。

長庚紀念醫院 基隆院區 牙科
受文日期：民國94年3月10日；接受刊載：民國94年5月4日
索取抽印本處：潘裕華醫師，長庚紀念醫院 牙科。基隆市204麥金路222號。Tel.: (02)24313131轉2469; Fax: (02)24313161; E-mail: philipcklin@msn.com