Cement spacing for the one-step post-core and crown. A new laboratory technique

M. Darveniza, MDSc, FRACDS*
K. Cheong†
K. E. Basford, AMusA(AMEB), BSc, PhD, MLitSt, FIS‡

Key words: Cement spacing, laboratory techniques, post-core and crown.

Abstract

A technique to provide cement spacing for cast post-cores prior to construction of their crowns is described. The axial lift of crowns cemented with zinc phosphate was greater, but not significantly, for crowns constructed on non-spaced post-cores compared with crowns constructed on spaced post-cores. Three materials were evaluated to determine their effectiveness in providing cement spacing for post-cores. The phenomenon of post-core 'wedging' during luting was identified.

(Received for publication October 1986. Revised July, September 1988. Accepted October 1988.)

Introduction

Cement spacing techniques[1-8] for crown construction have been evaluated and found to be effective in improving the seating of crowns on dies and following cementation.

The one-step laboratory procedure of fabricating a cast post-core and crown from the same impression has not been universally accepted by clinicians because of the occasional occurrence of unacceptable exposure of cement at the margins following simultaneous cementation of post-core and crown. This can be attributed to the axial lift or tilt of a post-core during cementation. Provision of cement spacing for a post-core could alleviate this problem of axial lift.

As the technique has not been reported in the literature but has been used by the author in speciality Crown and Bridge practice over an 11-year period it was decided to test its effectiveness.

Therefore changes following cementation in axial height of crowns constructed on spaced and non-spaced post-core/crowns were investigated.

Materials and methods

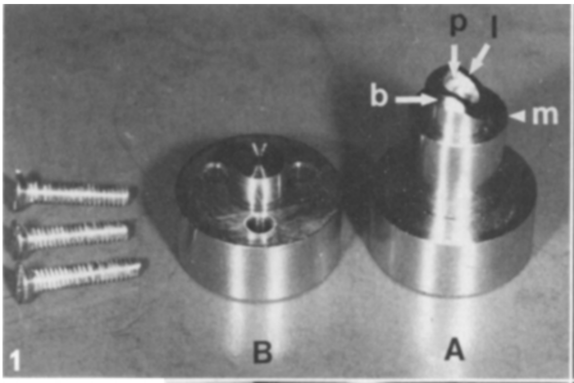
A sectional stainless steel master die was machined to simulate a post-core crown preparation of a maxillary central incisor tooth (Fig. 1). The crown preparation was 7 mm in diameter with a 1 mm shoulder and 5° tapered axial walls. The labial and lingual walls were approximately 3.5 mm and 1.5 mm high, respectively. The incisal edge was flat and the lingual surface sloped approximately 40° to the long axis to meet the lingual axial wall. An approximately 0.5 mm length 45° bevel was placed on the inciso-axial and linguo-axial line angles (Fig. 1).

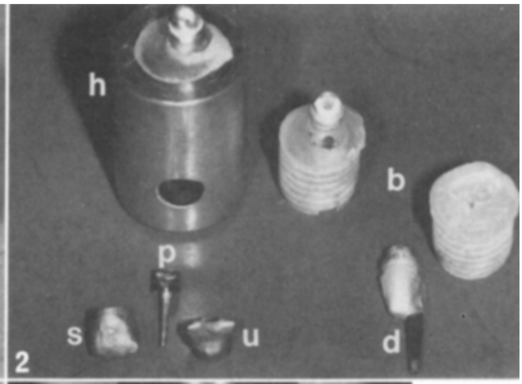
The post hole was approximately 11 mm deep inciso-apically, and was refined with a Size 3 engine reamer.§ The coronal one-third of the post hole was tapered and oval in cross section (Fig. 1). The apical two-thirds of the post hole was conical, with its truncated end sealed by the lower section of the die (Fig. 1). This arrangement allowed cleaning of the post hole.

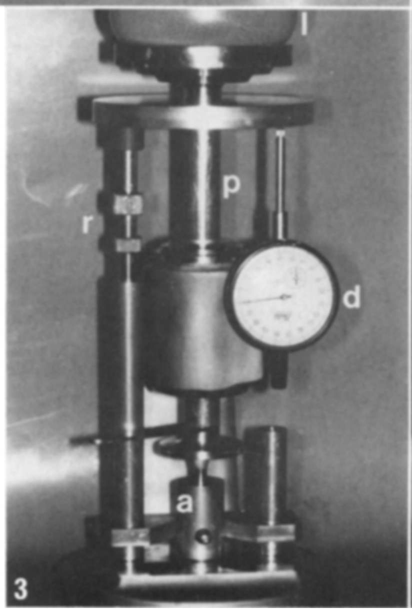
Ten polysulphide‖ impressions were made of the preparation and each was silver-plated. Each plated

*Formerly Lecturer in Operative Dentistry, Department of Restorative Dentistry, University of Queensland.
†Crown and Bridge Technical Instructor, Department of Restorative Dentistry, University of Queensland.
‡Statistician, Department of Agriculture, University of Queensland.

§P.D. Produits Dentaires SA, Vevey, Switzerland.
‖**Permlastic.** Kerr Mfg Co., Romulus, MI, USA.







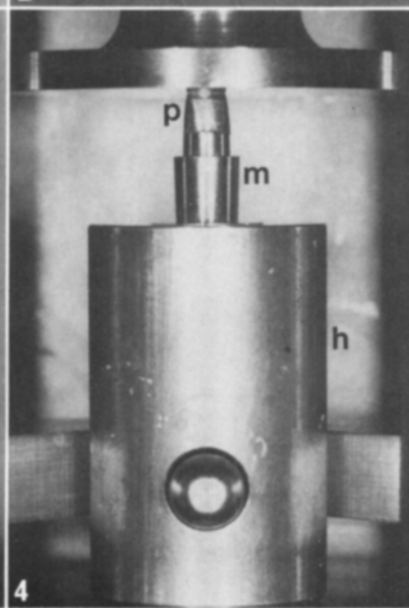


Fig. 1. – Upper portion of sectional master die (A) simulating post-core and crown preparation of a maxillary central incisor tooth machined in stainless steel. The proximal view of the post-core and crown preparation illustrates a 1 mm wide shoulder margin (m), sloping lingual surface (l). 11 mm deep post hole opening at the base of this part of the die (p) and bevelled inciso-axial angle (b). The lower portion of the die (B) can be screwed into the upper portion to seal the post hole.

Fig. 2. – Silver-plated acrylic resin die and a dowel (d) set into a brass holder (h) with acrylic resin is removed with a screw driver to form an acrylic block (b). Cast tapered post-core (p) made from each silver-plated die and two crowns constructed on the same post-core: spaced (s), unspaced (u).

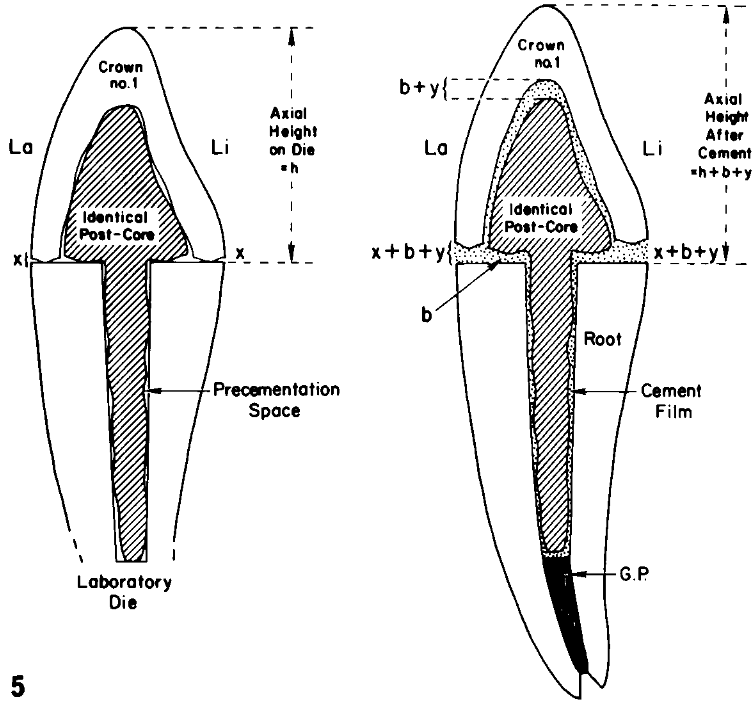
Fig. 3. – Custom compression and measuring device with an 7N movable piston (p), lead shot in plastic container (l), hand-operated raising device (r), dial gauge (d), and centred specimen assembly (a).

Fig. 4. – Master die (m) with post-core (p) secured in a brass holder (h) and centred in the custom compression and measuring device.

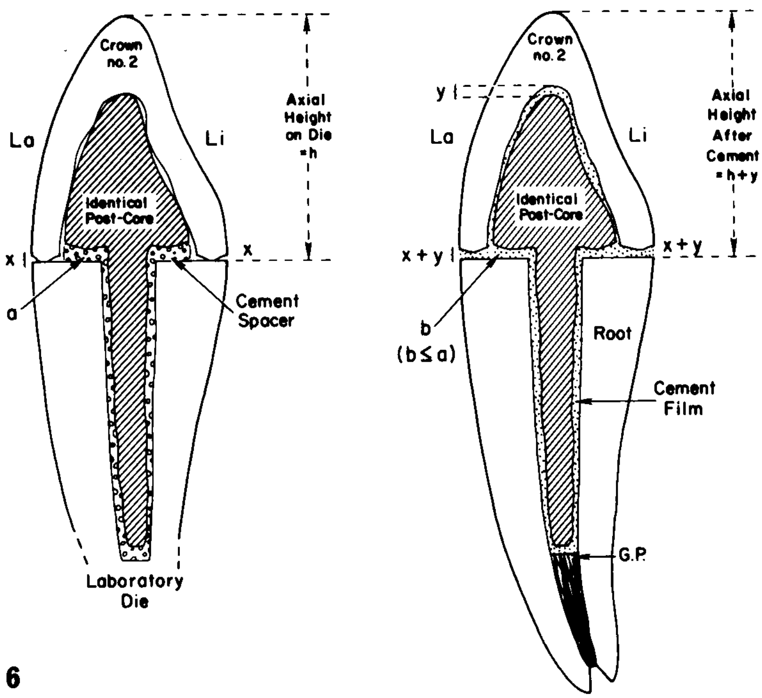
die was filled with self-curing acrylic resin and a centred dowel pin placed prior to polymerization. The die was removed from the impression, trimmed and tapered. A holder for the die was made in self-curing acrylic resin in a threaded brass cylinder (Fig. 2). After hardening, the holder was removed from the brass cylinder and the dowel pin/die assembly separated out as shown in Fig. 2.

A post-core was constructed for each silver-plated die using a non-precious alloy.¶ Each post-core was temporarily cemented** into its die held by its threaded acrylic resin block in the threaded brass holder. A lathe was used to flatten the incisal edge of each core at right angles to the long axis of the brass holder. The height from each core to the shoulder was approximately 8 mm.

¶**Unibond.** Unitek Corporation, Monrovia, CA, USA.
****Temp-Bond.** Kerr Mrg Co., Romulus, MI, USA.



5



6

Fig. 5.–Schematic diagram illustrating a possible internal and marginal 'fit' and precementation space of a post-core crown (No. 1) to a laboratory die. After cementation in a root, the post-core axially lifts by distance (b) and the crown by distance (y). This results in the marginal opening of the crown (x) on the die increasing to (x + b + y) on the tooth after cementation. Note, this assumes that the precementation space on the laboratory die at the incisal edge is non-existent, which is not necessarily the case.

Fig. 6.–Schematic diagram illustrating that if the identical post-core is cement-spaced by distance (a), where a ≥ b, before the crown (No. 2) is constructed on the laboratory die, a more favourable result occurs. The marginal opening of the crown (x) on the die increases to a maximum distance (x + y) on the tooth after cementation.

Each post-core was positioned in the post hole of the master model and positioned in a compression device (Fig. 3), seated under the load of the piston (7N), and the dial gauge read (Fig. 3). The load was increased to 150N by the addition of a container of lead shot to the piston and the dial gauge read. This was repeated for each of the following tests, namely, after spraying the post with a silicone spray,†† applying a die relief material‡‡ to the post hole, filling the post hole with a temporary crown cement,** and filling the post hole with a **ZOE** impression paste.§§ Ultrasonic cleaning‖‖ was performed between each test, and changes in axial height due to the application of these materials were recorded.

Ten crowns were made from the ten post-core/silver die assemblies using conventional methods and the same alloy as before (Fig. 2). The inciso-marginal height and mesio-distal width of each crown was approximately 10 mm and 8 mm, respectively. A lathe was used to flatten the incisal edge of each crown after reassembling the crown with its post-core die, threaded resin block and threaded brass holder, using the temporary cement. The flat was created at right angles to the long axis of the threaded brass holder (Fig. 4).

A second series of 10 crowns were made as described above except that each post-core was cemented under a 7N load into its die with **ZOE** impression paste before making the crown, thus 'cement spacing' the post-cores (Fig. 5, 6).

A compression device (Fig. 3) with dial gauge graduated 0.002 mm was used in cementing the post-cores and crowns to the master model and in measuring vertical change on cementation with zinc phosphate cement¶¶ (P/L 2.9). Room temperature was 23 ± 2 °C).

Each post-core was positioned into the post hole of the master die and placed in the compressive device under a load of 150N, 7N from the piston and 143N from a container of lead shot. Following the removal of the lead shot the zero position of each post-core was established under the load of the piston.

Each post-core crown was cemented by applying zinc phosphate cement to the post hole with a spiral root canal filler and to the post with an ox-hair brush. The post-core was then seated with a light finger pressure (2-3N) and minute rotations of the post-core, and excess cement brushed over the core before seating the crown (lined with cement) with a light finger pressure (Fig. 7). Immediately the assembly was transferred to the compression machine and a load of 7N applied by the piston. When the extrusion of cement ceased the dial gauge was read three times by removing and re-applying the load using the quick-action hand operated raising mechanism of the compression device (Fig. 3). Next, a load of 150N was applied and the dial gauge read three times after cessation of extrusion of cement. Each post-core crown combination was cemented three times in this way and the means of the dial gauge measurements at each load calculated.

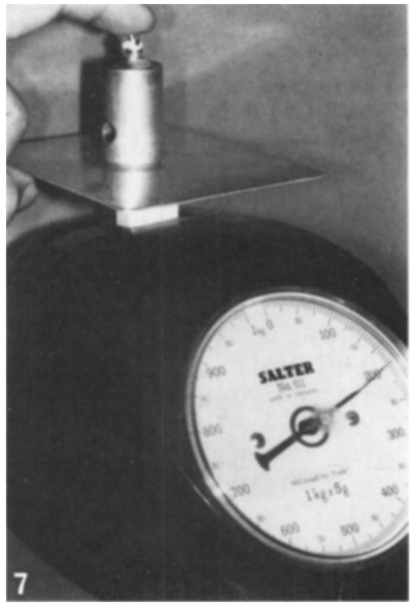


Fig. 7. – Loading device illustrating that, when luting (cement spacing) a post-core into a silver-plated die using **ZOE** (2:1) impression paste, a hand load of only 2 to 3N is required to seat a post-core at a suitable axial height for crown construction (Table 5).

Following measurement of vertical change of the post-core/crown combinations, each post-core was recovered, cleaned, and its vertical change on cementation was measured as described before.

Each post-core was cemented with **ZOE** impression paste into its silver-plated die located in its threaded acrylic resin block in the threaded brass holder under a load of 7N in the compression device and the change in axial height on cementation measured as before.

††**Slipicone.** Dow Corning Aust., Blacktown, NSW, Australia.
‡‡**Tru-Fit.** George Taub Products, Jersey City, NJ, USA.
§§S.S. White Co., Philadelphia, PA, USA.
‖‖**Denson.** L&R Mfg. Co., New Jersey, NJ, USA.
¶¶**Harvard.** Richter & Hoffman Harvard Dental Co., Berlin, East Germany.

Finally, each post-core was cemented with **ZOE** impression paste into the master die under a load of 7N with the compression device and with finger pressure of between 2 to 3 N, and minute rotations of the post-core, and the change in axial height was measured as before (Fig. 7).

Table 1. Change in axial height (micrometres) of post-core after 'luting' into the master die with surface tension reducing agent (*Slipicone*) film using 7N and 150N load

Post-core No.	Slipicone film 7N	Slipicone film 150N
1	-27	-34
2	-23	-24
3	-33	-35
4	-25	-26
5	-40	-40
6	-27	-25
7	-34	-35
8	-38	-41
9	-37	-32
10	-15	-16
x̄	-29.9	-30.8
SD	7.9	7.9

x̄ = Mean.
SD = Standard deviation.

Results

The results of changes in axial height of the post-cores positioned in the post hole of the master model following the use of different media on the post or in the post hole are shown in Table 1 and Table 2.

The results of changes in axial height of post-cores, crowns and non-spaced post-cores, and crowns and spaced post-cores are shown in Table 3.

A comparison of the changes in axial height of post-cores cemented into the master model with impression paste under a load of 7N and 150N with the changes when similarly cemented into the silver plated dies is shown in Table 4.

The changes in axial height of post-cores cemented into the master model with impression paste under a load of 7N compared with hand seating the post-cores with a load of 2 to 3N is shown in Table 5.

Discussion

The procedure of luting a post-core into a silver-plated die with a material for the purpose of cement-spacing of post-core prior to crown construction can inadvertently result in a negative axial change or wedging of the post-core into the die (Table 1). This

Table 2. Change in axial height (micrometres) of post-cores after luting into the master die with *Tru-Fit, Temp-Bond* and zinc oxide-eugenol (2:1) impression paste measured at 7N and 150N load

Post-core No.	Tru-fit 7N	Tru-fit 150N	Temp-bond 7N	Temp-bond 150N	Zinc oxide-eugenol (2:1) impression paste 7N	Zinc oxide-eugenol (2:1) impression paste 150N
1	6	-23	5	-23	50	-7
2	3	-30	18	-16	62	-11
3	9	-26	4	-28	92	-8
4	8	-14	10	-20	67	-13
5	7	-46	17	-28	139	-18
6	3	-35	2	-35	76	-12
7	4	-31	17	-33	99	-20
8	6	-30	5	-31	145	-14
9	5	-28	4	-34	146	-19
10	7	-11	4	-21	45	-9
x̄	5.8	-27.4	8.6	-26.9	92.1	-13.1
SD	2.0	10.0	6.4	6.6	39.1	4.6

Significance brackets (**): Tru-fit 150N vs ZOE 150N; Temp-bond 150N vs ZOE 150N; Temp-bond 7N vs ZOE 7N; Tru-fit 7N vs ZOE 7N.

x̄ = Mean.
SD = Standard deviation.
** = Significance at $p < 0.01$.

Table 3. Change in axial height (micrometres) of post-cores and crowns after luting into master die with zinc phosphate using 7N and 150N load

Post-core and crown no.	Post-cores 7N	Post-cores 150N	Crowns constructed on non-spaced post-cores 7N	Crowns constructed on non-spaced post-cores 150N	Crowns constructed on spaced post-cores 7N	Crowns constructed on spaced post-cores 150N
1	178	16	107	58	87	19
2	21	-20	42	12	85	12
3	131	22	105	21	47	20
4	94	20	56	27	23	9
5	142	22	33	11	68	15
6	56	6	71	29	61	20
7	178	12	49	22	32	9
8	198	35	45	10	51	11
9	42	0	126	20	46	19
10	41	24	108	30	86	16
	** (7N vs 150N)		* (7N vs 150N)		* (7N vs 150N)	
x̄	108.1	13.7	74.2	24.0	58.6	15.0
SD	65.7	15.4	34.0	14.0	22.8	4.5

x̄ = Mean.
SD = Standard deviation.
* = Significant at $p<0.05$.
** = Significant at $p<0.01$.

Table 4. Change in axial height (micrometres) of post-cores after luting into stainless steel master die and silver-plated dies with zinc oxide-eugenol (2:1) impression paste using 7N and 150N load

Post-core No.	Stainless steel master die 7N	Stainless steel master die 150N	Silver-plated dies 7N	Silver-plated dies 150N
1	50	-7	89	-59
2	62	-11	73	-46
3	92	-8	195	-17
4	67	-13	143	-31
5	139	-18	127	-36
6	76	-12	133	-44
7	99	-20	120	-40
8	145	-14	245	-30
9	146	-19	127	-47
10	45	-9	121	-11
		** (150N steel vs 150N silver)		
x̄	92.1	-13.1	137.3	-36.1
	* (7N steel vs 7N silver)			
SD	39.1	4.6	49.7	14.4

x̄ = Mean.
SD = Standard deviation.
* = Significant at $p<0.05$.
** = Significant at $p<0.01$.

Table 5. Change in axial height (micrometres) of post-cores after luting into master die with zinc oxide-eugenol (2:1) impression paste using 2 to 3N hand load with rotation of post-core and 7N static load of compression device

Post-core no.	2-3N dynamic hand load	7n static device load
1	36	50
2	34	62
3	58	92
4	50	67
5	34	139
6	110	76
7	74	99
8	54	145
9	74	146
10	124	45
x̄	64.8	92.1
SD	31.3	39.1

x̄ = Mean.
SD = Standard deviation.

wedging phenomenon was confirmed when a surface tension reducing silicone spray was used to coat and 'lute' the post-cores into a stainless steel die (Table 1). Although the post-cores were seated with a 7N and a 150N load the axial depression into the die was almost identical; namely, means of -30 and -31 μm, respectively. This indicates that reducing friction played a more important role in wedging than did load. Hence, the cement spacer chosen was a thick luting material to minimize wedging and **ZOE** (2:1) impression paste was used to create axial lifting.

When **Tru-Fit** and **Temp-Bond** were used on the post-core or in the post hole at either 7N or 150N load, no significant difference on average existed between the post-cores relative to change in axial height. Also, at the 150N load, post-cores in association with either **Tru-Fit** or **Temp-Bond** spacers were not significantly different with respect to seating as when lubricated with silicone, and therefore cannot be recommended as cement spacers for post-cores. However, when **ZOE** impression paste was used in the seating of the post-cores at both loads, significantly less seating occurred.

The results showed that it is possible to construct a post-core and crown pair using an impression paste (**ZOE**) as a post-core cement spacer, and to lute the pair with zinc phosphate into a master model to produce lower or similar axial lifts than an unspaced post-core and crown pair (Table 3).

It should be expected that significant differences in axial height would occur with such a post-core cement spacer. However, two interacting factors are believed to operate during final cementation that prevent large differences (Fig. 5, 6). The first factor is the amount of precementation space within the crowns, and in this study it was not possible to standardize the precementation space, in particular, at the incisal edge (Fig. 5). Those crowns tested with a large incisal space should have a decreased axial lift compared with other crowns with a small space, irrespective of the underlying post-core (Fig. 5, 6). The second factor is the phenomenon of wedging or negative axial change of a post-core during final cementation. Post-cores wedge further with larger loads and greater hydraulic pressure. Hence, the crowns with inherently smaller incisal precementation spaces were more likely to generate greater hydraulic pressure. This could have resulted in a post-core wedging more with a crown that had a smaller space at the incisal edge. The final axial lift of the abovementioned post-core/crown pair could then be similar to a crown with a larger space, as in this instance the post-core may not wedge. These two combining factors explain why predicted differences were not found using this research model.

In the development of the post-core cement spacing technique, there was concern that a silver-plated die may deform during luting especially under loading, and consequently it was tested and compared with a stainless steel die. The results showed that, when using **ZOE** (2:1) impression paste, wedging was significantly higher in a silver-plated die than a stainless steel die using a 150N load but not with the important 7N load (Table 4). It could be considered that this suitable and larger axial lift occurred because with a 7N load the silver-plated die does not demonstrably deform and may possess more friction than the 'smoother' stainless steel die which impedes the flow of cement.

As many of the tests were performed using the 7N static load, comparison was made with what a technician would use when luting a post-core by hand, that is, a 2 to 3N load with minute rotation of the post-core.

The results showed no significant difference between the dynamic hand load (2 to 3N) and the static load of 7N and, consequently, all the tests performed at the mechanical 7N load can be associated with the human methodology (Table 5).

Zinc oxide-eugenol impression paste is a practical material for use in post-core cement spacing of dies. These materials are easy to mix and apply to the post-core and will hydrodynamically locate, including inherent tilting or rotating, similarly to clinical luting cements. This paste can retain the post-core firmly in the die during crown or bridge construction. On completion of the prosthesis the post-core can easily be removed from the die by first weakening and softening the paste in warm water and then removing the post-core by hand. The paste can then be easily cleaned from the post-core and die using an ultrasonic cleaner and an appropriate solvent.

Conclusion

1. The phenomenon of wedging or negative axial changes of luted post-cores into stainless steel and silver-plated dies was measured with all the luting media used.

2. The impression paste **ZOE** (2:1) was suitable as a cement spacer for post-cores prior to crown fabrication, whereas **Tru-Fit** and **Temp-Bond** were unsuitable.

3. Zinc phosphate cemented spaced post-core/crowns seated better in an axial direction but not significantly different from the unspaced post-core/crowns.

4. Silver-plated dies are suitable for post-core spacing when using a 7N load but not with a 150N load.

5. Light 2 to 3N hand loads, with minute rotating of the post-core, were suitable to use for cement spacing post-cores when using **ZOE** (2:1) impression paste.

Acknowledgements

We would like to express our gratitude to Mr G. Dick, Head Technician, Metrology section, Mechanical Engineering, University of Queensland, for his help with measurement, construction of the die and facing of the post-cores and crowns. Our thanks go to Mr D. Lund, Medical Photographer at the Queensland Dental School, for his excellent photography, and Mr C. Jung, Medical Illustrator at the Michigan Dental School, for his excellent drawings.

References

1. Fusayama T, Ide K, Kurosu A, Hosoda H. Cement thickness between cast restorations and preparation walls. J Prosthet Dent 1963;13:354-64.
2. Hollenback GM. A practical contribution to the standardization of casting techniques. J Am Dent Assoc 1928;15:1917-28.
3. Bassett RW, Status BM. Evaluation of electrochemical milling (stripping) versus etching with aqua-regia. J S Calif Dent Assoc 1966;34:478-83,
4. Fusayama T, Ide K, Hosoda H. Relief of cement of full cast crowns. J Prosthet Dent 1964;14:95-106.
5. Eames WB, O'Neal SJ, Monteiro J, Miller C, Roan JD, Cohen KS. Techniques to improve the seating of castings. J Am Dent Assoc 1978;96:432-7.
6. Bassett RW. Solving the problems of cementing the full veneer cast gold crown. J Prosthet Dent 1966;16:740-7.
7. Darveniza CM. A comparison of the internal and marginal adaptation of full cast crowns as cast, after venting and after electrochemical etching. Brisbane, Queensland: University of Queensland, 1980. MDSc thesis.
8. Ostlund LE. Improving the marginal fit of cast restoration. J Am Acad Gold Foil Oper 1974;17:56-65.

Address for correspondence/reprints:
K. Cheong,
Department of Restorative Dentistry,
University of Queensland,
Dental School,
Turbot Street,
Brisbane, Queensland, 4000.