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Effect of Screw Hole Filling on Retention of Implant Crowns

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Abstract - *The screw access channels of 15° angled Esthetic Abutments (Brånemark System®) were either (a) completely filled with a vinyl polysiloxane impression material (Memosil), (b) partially filled with Memosil or (c) had lower portion filled with Memosil and the remainder with composite resin. The force required to remove a temporarily cemented restoration was measured. The removal force was significantly reduced with the channel completely filled with Memosil compared to those partially filled with Memosil ($p<0.01$) or with composite resin placed over Memosil ($p<0.01$). The method selected to fill the screw access channel of an implant abutment can be a significant factor affecting retention of a cemented restoration.*

KEY WORDS: Implant abutment, Screw hole filling, Retention

INTRODUCTION

Screw-retained, implant supported prostheses were developed in response to the need for retrievability of restorations should removal be required. As techniques continue to evolve, the survival rates of implant-retained restorations are improving[1]. Consequently, the use of cement retained, implant supported restorations has increased, due in part to the ability to optimise occlusal interdigitation, enhance aesthetics in areas that would otherwise be the locations of screw access holes, and provide a passive fit, which may actually improve loading characteristics[2].

Many of the present-day implant systems have screw retained abutments onto which restorations can be cemented. The majority of abutment preparation designs and cementation techniques now mimic conventional fixed prosthodontic procedures for natural teeth. Factors that influence the retention of conventional cement-retained restorations have been well documented[3–6]. Factors that have currently been shown to be of importance in the retention of restorations on implant abutments are taper[7], size[8], length[7] and cement type[7–10]. One clear difference between an implant abutment and a natural tooth preparation is the presence of a screw access channel.

Methods of managing the screw access channel prior to cementation of the restoration include partial or complete filling with silicone impression material or restoring the abutment contour with a composite resin material after first protecting the screw head with a smaller amount of silicone. Such methods are used to prevent cement from reaching the head of the abutment screw and thus complicating later clinical access should it become necessary. The method that is chosen is at present largely dependent on operators' preference and convenience and has little scientific basis.

The aim of this laboratory study was to investigate the effect of the methods used to fill the screw access channels of abutments on the removal force of a final restoration cemented with Temp Bond®.

MATERIALS AND METHODS

15° angled regular platform Esthetic Abutments (Brånemark System®) were chosen for use in this study as they are clinically commonly used pre-formed standardised abutments with a screw access channel. Three were attached to their implant replicas and identically vertically mounted in acrylic resin to permit a tensile force to be applied in the long axis of the axial form of the abutment. The mounting resulted in the implant replica being buried to simulate the implant in bone, with the head of the implant exposed for restoration (see *Figure 1*).

The access holes of the abutments were carefully blocked out and a putty matrix of the abutment shape constructed. Two layers of die spacer were painted to within 2mm of the margin and type III gold castings with an attachment were constructed (see *Figure 1*). The exterior of the castings was polished while the interiors were left untouched.

The screw access channels of the abutments were either: (i) completely filled with a vinyl polysiloxane impression material – Memosil (see *Figure 2*), (ii) partially filled so that the screw was covered with Memosil up to the horizontal level of the open access channel (see *Figure 3*) or (iii) had the lower portion filled with Memosil as with the partially filled specimens and the top portion with composite resin (XRV Herculite) (see *Figure 4*). Care was taken to maintain all filling methods within the contour of the abutment using the original putty matrix for guidance.

Weighed amounts of Temp Bond® were used for the cementation of the castings on the implant abutments,

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Figure 1. *Picture to show mounting of implant replica and abutment in acrylic resin and casting constructed on top*

Figure 2. *Picture of abutment fully filled with Memosil*

Figure 3. *Picture of abutment partially filled with Memosil*

Figure 4. *Picture to show abutment fully filled with composite*

mixed for thirty seconds in proportions according to the manufacturer instructions. The mixed cement was placed into the castings using a crown-fill technique, seated on to the abutment with finger pressure and placed under a 5kg seating force in a static-loading machine for five minutes. Excess cement was removed using a plastic instrument. The assemblies were then stored in 100% humidity at 37°C for twenty-four hours.

A universal load-testing machine (Instron) was used to measure the force required to remove the castings from the abutments. With reference to previous studies using the same machine, the crosshead speed was set at 5mm per minute[8,10,11]. The force required for complete separation of the castings from the abutments was recorded. The procedure was repeated twenty times for each filling modality.

RESULTS

Figures 5–7 show typical force/displacement graphs for each of the filling methods used in this experiment.

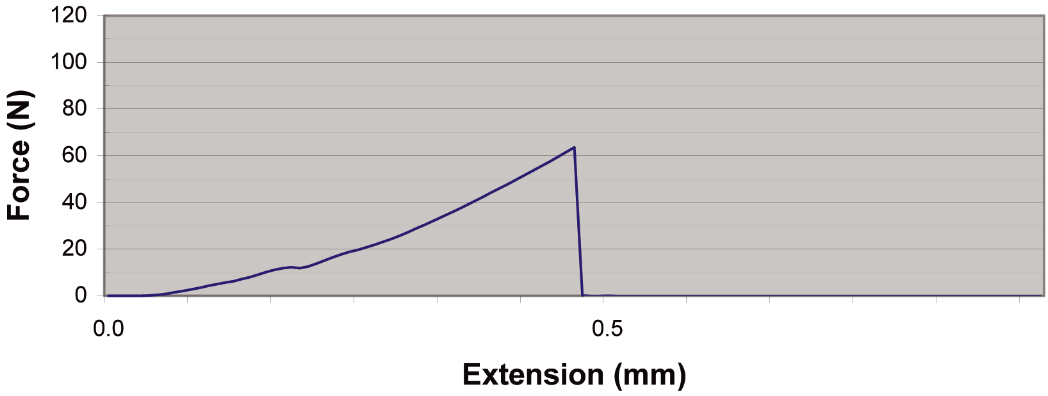

Figure 5. *Force/displacement graph of a fully filled Memosil specimen*

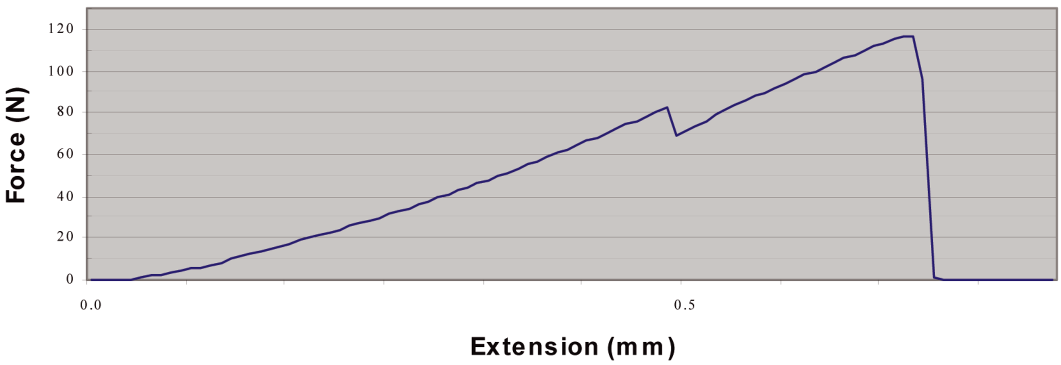

Figure 6. *Force/displacement graph of a fully filled Composite specimen*

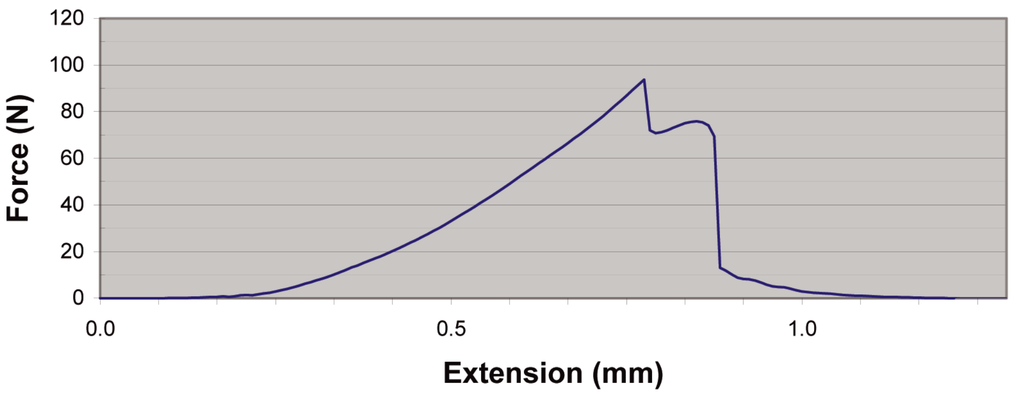

Figure 7. *Force/displacement graph of a partially filled Memosil specimen*

Table 1. *The mean peak removal force of the different filling materials.*

Filling method	*Mean removal force*	*Standard Error*	*95% Confidence Interval*	
			Lower bound	*Upper bound*
FFM	61.78	2.18	57.44	66.10
PFM	90.81	2.18	86.48	95.13
FFC	97.70	2.18	93.37	102.00

Table 1 shows the mean peak force of the three filling methods. This data is shown graphically in *Figure 8*. The fully filled Memosil (FFM) group had the lowest peak removal force, while the partially filled Memosil (PFM) and fully filled composite (FFC) groups had a similar peak force.

After the removal of the cemented abutments the pattern of the cement distribution was noted. For the FFM group all the cement was found on the fitting surface of the castings, while there was no cement left on the abutment surface. For the FFC group, cement was found on the fitting surface of the castings except

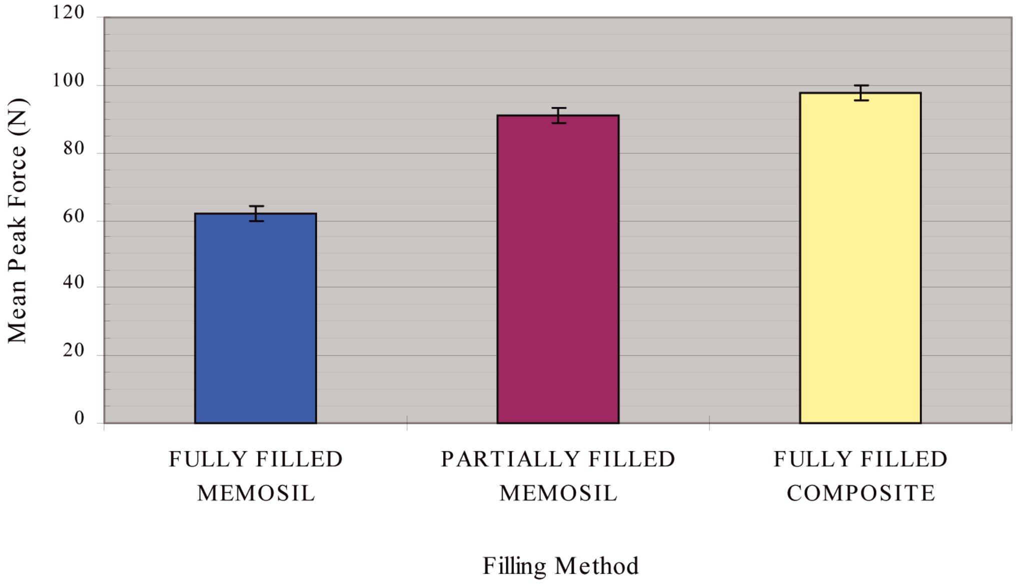

Figure 8. *Bar graph to show the mean peak removal force and the 95% confidence interval for the different filling methods.*

Table 2. *Multiple comparisons (Bonferroni) between the three filling methods*

Filling method		*Mean difference*	*Standard Error*	*Significance*	*95% Confidence Interval*	
					Lower bound	*Upper bound*
FFC	PFM	6.89	3.09	0.083	–0.62	14.40
FFC	FFM	35.93	3.09	<0.001	28.42	43.43
PFM	FFM	29.04	3.09	<0.001	21.53	36.54

that in direct apposition of the composite surface after separation, where the Temp Bond® had adhered to the composite. For the PFM group all the cement adhered to the fitting surface of the casting but with a block of cement always left in the screw access channel.

Multiple comparisons (Bonferroni) between the three filling methods, showed that there was no statistically significant difference between the mean removal force of the PFM and the FFC groups, but there were significant differences ($p<0.001$) between the FFM and PFM groups, and between the FFM and FFC groups (see *Table 2*).

DISCUSSION

Cement-retained, implant-supported prostheses have gained popularity because they allow completion of clinical procedures using conventional fixed prosthodontic techniques. In the absence of occlusal screw access opening, cemented implant-supported restorations offer enhanced aesthetics and the potential for an increased number of occlusal contacts.

One of the major concerns with cemented restorations is the challenge of retrieval when an abutment screw loosens. A cast restoration that fits well may be difficult to remove after provisional cementation to a prepared tooth[7]. Likewise, a casting for an implant abutment may be difficult, if not impossible, to retrieve without sectioning it[7]. Clinically if there is a risk of screw loosening and the retentive form of the abutment is good, the results of this study suggest that fully filling the screw access channel with Memosil, when cementing with Temp Bond®, would be appropriate to minimise contribution of the filling method to retention.

Conversely, if the retentive form of the abutment is compromised, for example, loss of length[7], then the method used to fill the screw access channel should be such that its contribution to removal force should be maximised with the screw access channel being partially filled with Memosil or fully filled with composite (with the screw head protected first).

The limitations of this study should be noted, since it only investigated retention and not resistance. Clinically removal of castings might not employ forces along a single path of withdrawal.

For the FFM group cement was found mostly on the fitting surface of the castings whereas there was no cement left on the abutment surface. This implies that Temp Bond® adhered to the (possibly rougher) gold fit surface much more strongly than to the titanium/Memosil surface. The cement breakage seemed to occur in an instant on analysis of the force displacement graphs as the force recorded dropped sharply after the break and the castings fell apart immediately.

For the FFC abutments, cement was found on the gold surface of the casting, except that in direct apposition to the composite surface after separation, where the Temp Bond® had adhered preferentially to the composite. Again no cement was found on the titanium surface which was in the as-supplied polished state. The force/displacement graph showed the cement break in two or more progressions. It is highly likely the lower preliminary peak was due to the cement break at the weaker titanium/

Temp Bond® interface and the highest one was due to that at the stronger gold/Temp Bond®/composite interface.

The cement breakage in the PFM group appeared to be in a more gradual manner. Cement adhered to the gold surface with a block of cement always left in the screw access channel. This is almost certainly a consequence of part of the channel forming an undercut relative to the axial surfaces of the abutment and is a potential source of retention that does not appear to have received attention to date. It may explain why the PFM group had a higher removal force than the FFM, as force was needed to cause a cohesive fracture within the Temp Bond®. It is likely that a similar effect could be expected with other cements including permanent luting agents but further work is required to confirm this.

CONCLUSIONS

Within the limitations of this laboratory study the following conclusions may be drawn:

(1) The method employed to fill the screw access channel of implant abutments can have an effect on the retention of coronal restorations cemented with Temp Bond®.

(2) Fully filling the screw access channel with an elastomeric impression material reduced the removal force of a coronal restoration cemented with Temp Bond®.

(3) Partially filling the screw access channel with elastomeric material or fully filling with composite resin (with the screw head protected first) increased the removal force of a coronal restoration cemented with Temp Bond®.

MANUFACTURERS' DETAILS

- Implant components(Brånemark System®, Nobel Biocare™) - 15° Angled Esthetic™ Abutment, regular platform, 3mm (including abutment screw). Implant Replica RP.
- Type III gold alloy EC830 (Degussa AG, Geshaftsberich Dental, Germany).
- RP self-curing clear acrylic resin (Dentsply DeTray GmbH, England).
- Memosil 2 vinyl polysiloxane (Heraeus Kulzer GmbH & Co. KG, Germany).
- Herculite XRV composite resin restorative material (Kerr, England).
- Temp Bond® (Kerr Italia S.p.A., Italy).
- Advanced formula Temporary Cement Remover (Premier Dental Products Co. USA).
- Die spacer (Belle de St Claire, Kerr Laboratories, Orange, CA).

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REFERENCES

1. Adell, R., Eriksson, B., Lekholm, U. *et al.* A long-term follow-up study of osseointegrated implants in the treatment of totally edentulous jaws. *Int. J. Oral Maxillofac. Implants*, 1990; **5**: 347–359.
2. Hebel, K.S. and Gajjar, R.C. Cement-retained versus screw-retained implant restorations: Achieving optimal occlusion and esthetics in implant dentistry. *J. Prosthet. Dent.* 1997; **77**: 28–35.
3. Jorgensen, K.D. The relationship between retention and convergence angle in cemented veneer crowns. *Acta. Odontol. Scand.,* 1955; **13**: 35–40.
4. Kaufman, E.G., Coelho, D.H. and Colin, L. Factors influencing the retention of cemented gold castings. *J. Prosthet. Dent.,* 1961; **11**: 487–502.
5. Gilboe, D.B. and Teteruck, W.R. Fundamentals of extracoronal tooth preparation. Part 1. Retention and resistance form. *J. Prosthet. Dent.,* 1974; **32**: 651–656.
6. Guyer, S.E. Multiple preparations for fixed prosthodontics. *J. Prosthet. Dent.,* 1970; **23**: 529–553.
7. Bernal, G., Okamura, M. and Munoz, C.A. The effects of abutment taper, length and cement type on resistance to dislodgement of cement-retained, implant supported restorations. *J. Prosthodont.,* 2003; **12(2)**: 111–115.
8. Covey, D.A., Kent, D.K., St Germain, H.A. and Koka, S. Effects of abutment size and luting cement type on the uniaxial retention force of implant-supported crowns. *J. Prosthet. Dent.,* 2000; **83(3)**: 344–348.
9. Ramp, M.H., Dixon, D.L., Ramp, L.C., Breeding L.C. and Barber L.L. Tensile bond strengths of provisional luting agents used with an implant system. *J. Prosthet. Dent.,* 1999; **81(5)**: 510–514.
10. Clayton, G.H., Driscoll, C.F. and Hondrum, S.O. The effect of luting agents on the retention and marginal adaptation of the CeraOne implant system. *Int. J. Oral Maxillofac. Implant.,* 1997; **12**: 660–665.
11. Breeding, L.C., Dixon, D.L., Bogacki, M.T. and Tietge J.D. Use of luting agents with an implant system: Part 1. *J. Prosthet. Dent.,* 1992; **68**: 737–741.