Safer Intra-Oral Cementation: Prevention of Cement Voids under the Prosthesis.

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Abstract: *There is much literature about the biological problems related to current cementation techniques, especially those that try to reduce cement volume, can cause unwanted cement voids under a prosthesis. These voids can be due to 1) air entrapment under the prosthesis, 2) an uneven distribution of cement caused by tilting the prosthesis during installation and 3) changes of prosthesis seating pressure during the process of cementation. The author proposes a method of prosthesis cementation that can minimize the possibility of cement voids at the margin of the prosthesis. Indeed visible excess cement should be expressed from around the entire margin of the prosthesis and held in place until the cement sets, before removal of excess cement. The proposed cementation technique can be used for prosthetics cemented onto natural teeth and dental implants. It is designed to help prevent the entrapment of air or tissue fluids at the prosthesis margins during the process of intra-oral cementation. This promises to make dental treatment involving intra-oral cementation safer.*

Introduction: There is much literature about the biological problems related microleakage around the margins of the dental prosthesis. Microleakage of prosthetics cemented onto natural teeth can result in recurrent decay, pulpal infection and periodontal inflammation. Microleakage at the margins of a prosthesis cemented onto dental implants would likewise be suspect for contributing to peri-implant disease, as oral pathogens are known to inhabit cement voids and can cause unwanted problems in adjacent tissues. Microleakage between implant-abutment connections are a known risk factor for peri-implant disease. Indeed, the participants contributing to the “Consensus Report of the Sixth European Workshop on Periodontology”, acknowledged that the most common lesions of peri-implant disease are caused by bacteria. (1)

Treatment involving dental implants has become widely accepted. However there are growing concerns regarding peri-implant disease. (2,3,4) The prevalence of peri-implant disease appears to be similar for fixed prosthetics, whether they are installed by a screwed-in technique or by intra-oral cementation. (5,6,7,8) It appears that the significant iatrogenic contribution to peri-implant disease may relate to the implant-abutment misfit caused by the screw-in technique, (9,10,11,12,13) and residual subgingival cement caused by intra-oral cementation. (14,15,16) Research by the author sheds some light upon the problematic effect of abutment design, prosthesis design and adjacent gingiva on the flow of excess cement and suggests ways to

mitigate this effect. Controlling the flow of excess cement can reduce the prevalence of residual subgingival cement (17,18,19,20) and its negative consequences.

Residual subgingival cement has been a longstanding problem resulting from the process of intra-oral prosthesis installation. (14) One of the proposed solutions to this problem involves the reduction of cement volume to reduce the quantity of excess cement extruded from the margins of the prosthesis. Cement volume can be reduced by 1) minimizing the amount of cement loaded into the prosthesis before cementation, 2) using a retainer replica to express excess cement from the intaglio surfaces of the prosthesis before cementing it onto its' retainer(s) and/or 3) venting the cement space through the prosthesis and into the oral cavity away from the gingival tissues, and/or 4) venting excess cement into the implant–abutment cavity. All these methods propose to reduce the volume of excess cement expressed from the margins of the prosthesis and thus reduce the volume of cement that is ejected into the subgingival environment. The researchers propose that reduction on the volume of cement ejected into the subgingival space may reduce the problem of residual subgingival cement. (21,22,23,24,25,26)

These cement volume reduction techniques can be fraught with unintended difficulties. The challenge of these cement volume reduction techniques relate to being able to apply "just the correct amount of cement" to the intaglio surfaces of the prosthesis to 1) adequately retain the dental prosthesis and 2) not cause excess cement to be extruded beyond the margins of the prosthesis and 3) fill all the space between the retainer and the prosthesis to exclude oral pathogens from its inner spaces. Franky, this is a very difficult feat to accomplish, even under ideal conditions in an "in vitro" environment. The problem is made even worse by the fact that tilting the prosthesis during intra-oral cementation can have a negative effect on the efficacy of crown seating procedures. (27)

It may be difficult for the clinician to detect and remove subgingival excess cement expressed from the crown margins. However signs of inflammation may lead a clinician to explore the inflamed subgingival environment with an endoscope or view the area after raising a surgical flap. Once detected, residual subgingival cement could be removed with a reasonable expectation for the normalization of the site. (14)

What about detecting and normalizing inflamed tissues adjacent to cement voids? There is no practical way to detect cement voids under a prosthesis that is opaque. Perhaps if the void is under a thin translucent crown or a facing and it is contaminated with blood products or dark stains or black microbial growths, well then it might be

possible to diagnose the existence of a cement void. Cement voids could be difficult to treat effectively without replacing the prosthesis. This can be expensive.

This study demonstrates how current cementation techniques, especially those that try to reduce cement volume, can cause unwanted cement voids under a prosthesis. These voids can be due to 1) an uneven distribution of cement caused by tilting the prosthesis during installation 2) air entrapment under the prosthesis, and 3) changes of prosthesis seating pressure during the process of cementation. The author proposes a method of prosthesis cementation that can minimize the possibility of creating cement voids at the margin of the prosthesis.

Material and Methods:

Aluminum Cylinders with various Margin Designs including Tapered Margin (TM), an inflected margin design referred to as the Reverse Margin (RM) and a Chamfer (CM) **(Fig 1)**. The aluminum rods were turned by Phil's Precision Machining, ppmachining@ppmachining.ca. Milan Jovanovic RDT created the plastic translucent crowns with an 80 micron cement space (Fig 2). They were scanned by a Sirona Eos Blue, designed with Sirona 4.3 software and milled with a Sirona MCXL milling machine. The blocks were made for InLab from Vita CAD - WAXX CW 40.

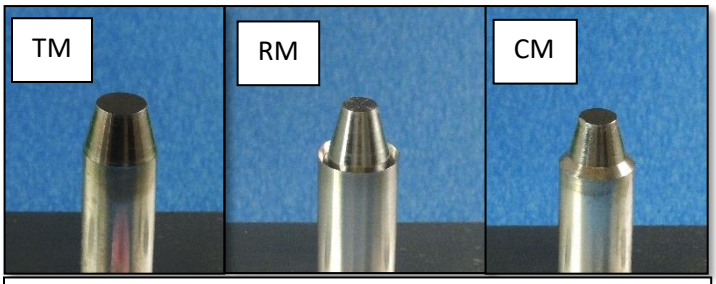

Fig 1 shows aluminum cylinders with a Tapered Margin (TM), Reverse Margin (RM) and Chamfer Margin (CM)

In group 1 experiments, a pink cement substitute DAP (DryDex spackling compound made by DAP Products Inc. Baltimore, MD 21224) was smeared into crowns with three different margin designs (TM, RM, CM). The cement was applied to cover the entire inside of the crowns and fill them to about 1/3 to 1/2 full. **Fig 2** shows a crown with cement in its intaglio surface sitting upside down beside an aluminum rod with a TM design. Each crown was pressed into place using a cement mixing spatula

Fig 2 shows clear plastic crown with Tapered Margin (**TM**) sitting upside down with cement loaded into its' intaglio surface. It rests next to the Tapered cylinder.

modified with a greenstone rotating disc. The disc was used to cut an angular indent into the spatula so that it would fit securely onto the crown during the cementation process. The indent made it easier to control the direction of force application. The experiment was first performed with the spatula placed into the central groove of the crown. **(Fig 3)** A downward vertical force was used to seat the crown into place and to observe the pattern of excess cement flowing out of the crown margin during this process. The experiment was then repeated with the spatula at an offset angle, about 26 degrees from the vertical. **(Fig 4)** The crown seating pressure was applied onto the right marginal ridge of the crown. This process was repeated with crowns with the two other margin designs.

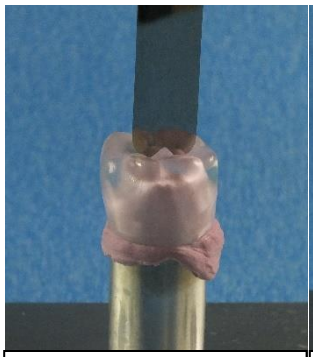

Fig 3 Crown with **TM** has been pushed into place with a vertical seating force delivered by the cement spatula. See excess cement flow.

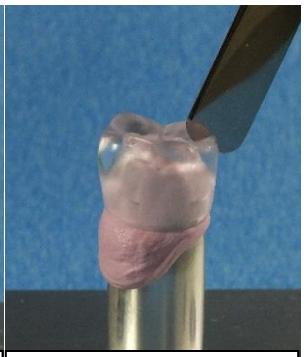

Fig 4 Crown with **TM** has been pushed into place with a 26˚ off vertical force. More cement opposite applied force.

Fig 5 (a,c) shows two margin designs (RM & CM) on retaining rods and then crowns pushed in place by an angled force applied by the spatula. The expressed cement pattern is evident in **Fig 5 (b,d).**

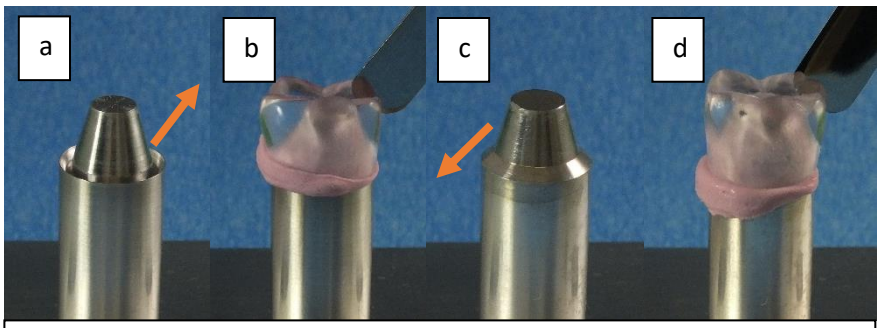

Fig 5 (a) is a RM design. **(b)** is RM with an angled crown seating force applied by the spatula. Note the cement is expressed preferentially from the margin opposite the applied force and the cement has moved up towards the occlusal surface of the crown. **(c)** is a CM and **(d)** shows the crown seated with an angled seating force. The cement is expressed preferentially from the side opposite the applied force and the cement moves in the direction of the margin - down. The **orange arrows** designate the angle of the margins.

In the second group of experiments, A blue hard silicone putty material, (Platinum95 from Zetalabor Technical) base and catalyst were mixed together in equal parts and then squeezed into the Tapered Margin (TM) crown form and allowed to set to create a retainer replica. This was a technique similar to that proposed by Wadhwani and Pineyro (2009).(26) **Fig 6(a)** shows a retainer replica with a clear crown in place and the replica without the crown **(b)**. On the right, the crown, loaded with cement (DAP) has been pushed into place onto the replica to express some of the excess cement **(c)**. **Fig 6(d)** shows some of the

cement sticking to the replica after removal of the crown and **(e)** shows the uneven pattern of cement on the intaglio of the crown. This is after wiping away the external excess cement with a cloth and before seating it onto the rod retainer with the TM **(f)**.

The experiment was then repeated with Pressure Indicator Paste 101-6865 from Henry Schein **(Fig 7)** and Rely X Ultimate Cement from 3M Espe. Pictures were taken of the results. **Fig 8** shows the crown **(a)** loaded with RelyX Ultimate from 3M Espe, **(b)** in place on the retainer replica to express excess cement, and back in place on the retainer. **(c)**

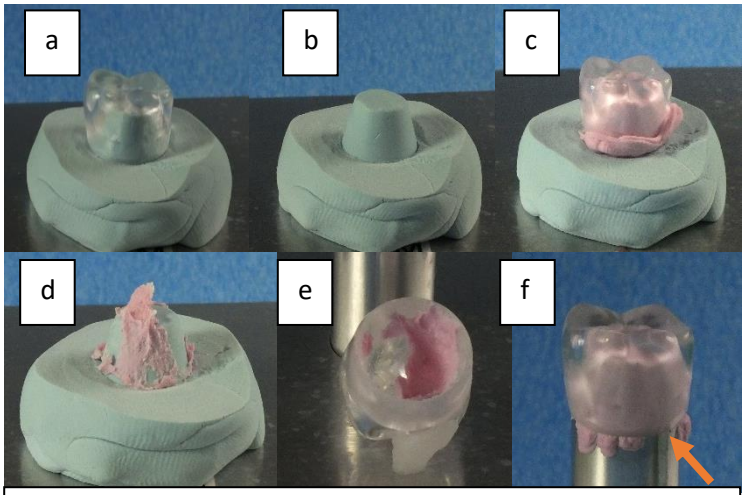

Fig 6 Clear crown (a) is used to make the replica (b) to push excess cement (DAP) out of the crown (c).Remaining cement on replica after removal of crown. (d) Cement remaining on inside of crown. (e) Crown seated onto Tapered Rod. (f) Arrow shows entrance to cement void on margin. Note uneven ejection of cement.

Results:

In group 1 experiments, the tapered margin was tested with a vertical force. **(Fig 4)** One can see that the cement is extruded relatively evenly around the margins of the crown. However, there are areas adjacent to the crown

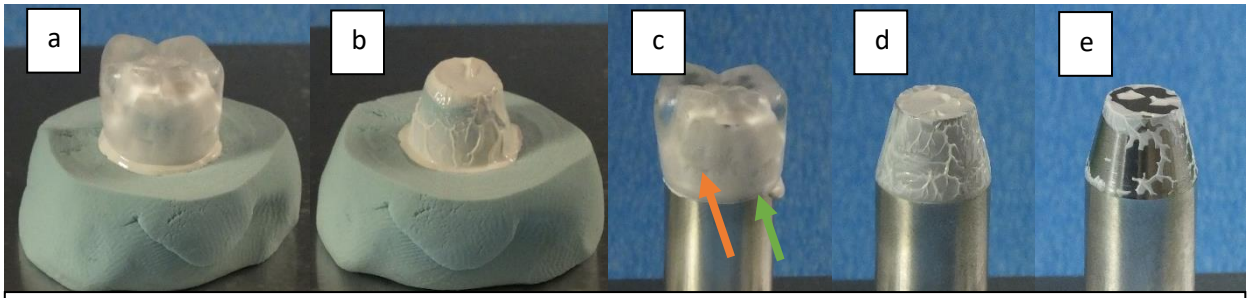

Fig 7 Crown in place with expressed excess cement (a). Cement remaining on replica when crown removed. (b) Note uneven distribution of remaining cement. Crown with remaining cement placed onto rod with tapered margin. (c) Note outline of grey void visible under crown (orange arrow) and void at margin (green arrow). Uneven distribution of cement left on rod (d) when crown in (c) is pulled off. Uneven distribution of residual cement on rod that was cleaned of cement after crown is replaced on rod and then removed. (e) The crown seated on this rod would have had large cement voids.

margins that have more cement and less cement. The excess cement outflow is not uniform, in spite of best efforts to apply a vertical crown seating pressure.

When all three crowns with different margin designs **(Figs 4,5)** were tested with an offset force onto the right marginal ridge, most of the excess cement was expressed from under the left crown margin. When an offset force was applied during the crown installation, it affected the direction and volume of cement flowing from out between the margins. The excess cement flow was greater at the side of the crown opposite the applied force. Less cement was expressed on the side of the crown under the applied force. The

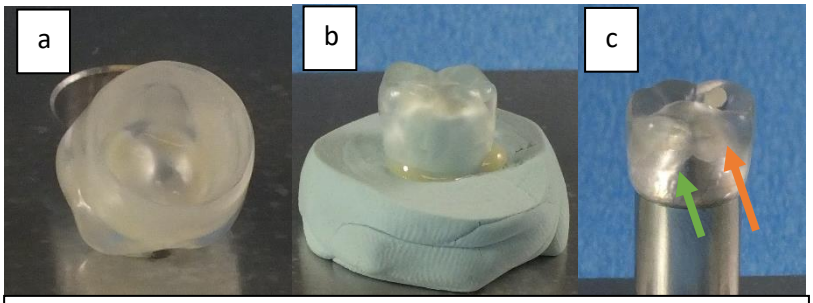

Fig 8 Intaglio of crown with cement. (a) Crown in place over replica with expressed excess cement. (b) Crown in place over retainer with cement voids apparent. (c) Green arrow indicates location of void near margin. This void near the margin is contiguous with large void under crown. The orange arrow points to the outline of large cement void under crown. It is a clear area with an irregular shape.

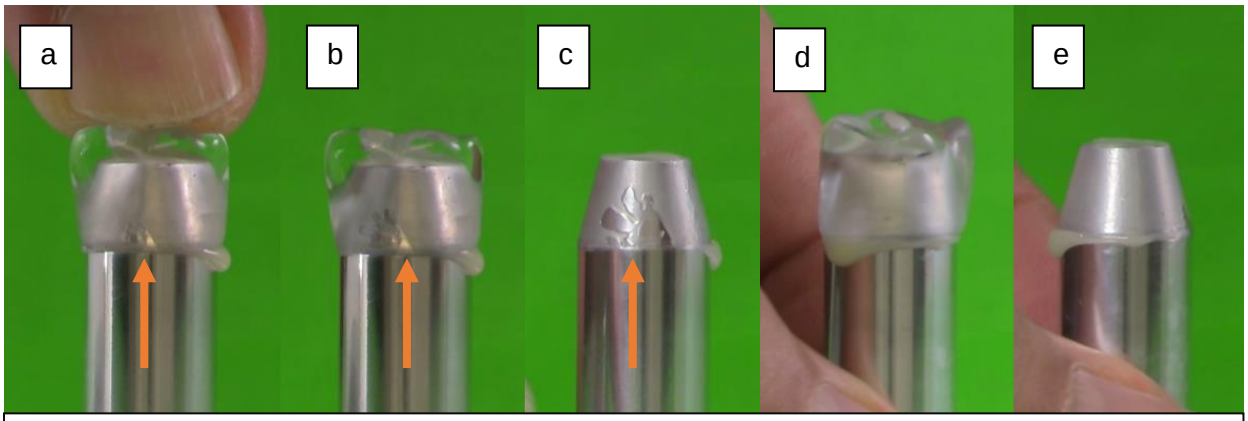

Fig 9 (a) Crown held in place under finger pressure while cement still fluid. Cement void visible through crown (orange arrow) and was minimized in size under pressure. (b) As pressure was released, the crown rose and air was drawn under the margin of the crown and the cement void grew in size. (c) With the crown removed, the size of the cement void is clearly visible. The margin of the crown was open to contamination from the external environment. (d) In regions of the margin with excess cement there were no cement voids. When the crown lifted, some of the excess cement adjacent to the margin was drawn into the intaglio of the crown. (e) With the crown removed it is possible to see the continuous sheet of cement that filled the space between the crown and the retainer. There are no voids and it would be difficult for microbes to penetrate the barrier of cement at the margin.

cement exiting from the margins of the RM **(Fig 5b)** moved up towards the occlusal of the crown rather than down like the other two margin designs **(Figs 4,5d)**.

In group 2 experiments, in every case, reducing cement volume resulted in cement voids visible through the transparent crown material. **(Figs 6,7,8)**. The Pressure Indicator Paste showed the best fill when the Bite Registration Technique was used to reduce cement volume. However, when the crown was re-cemented onto the retainer with remaining material adherent to the crown, cement voids were evident.

When the crowns were pulled off the retainer replica, the cement on the inside of the crown and on the retainer replica was uneven. This appeared to result from a suction effect that resisted crown removal. **(Figs 6d,7bde)** When Rely X was used with the cement replica cement reduction technique, it also resulted in visible voids at the crown margin and unde the crown. **(Fig 8 a,b,c)**

Fig 9 is a series of pictures clipped from a video published by the author. (29) The cement volume used for cementation onto the retainer was determined according to the retainer replica technique described above. **(a)** This shows a clear acrylic crown under finger pressure, seating the crown into place on its retainer. There is a small cement void at the margin of the crown as designated by the orange arrow. **(b)** As the pressure is released, the crown appears to rise slightly and the cement void grows in size. **(c)** With the crown removed the, extent of the cement void is visible and it is continuous with the margin of the crown. **(d,e)** Areas of the crown with excess cement at the margins do not display any cement voids.

Discussion:

It is clear that clinicians would like to find a safer process for cementing prostheses onto retainers inside the oral environment. This process would need to retain the prosthesis, prevent the occurrence of residual subgingival cement and prevent cement voids that can render the prosthesis, retainers and surrounding tissues open to infection by oral pathogens. When restoring natural teeth, cement voids can result in caries under retainers and inflammatory disease in adjacent periodontal tissues. Cement voids can also result in discolored facings and crowns and bridges when they are made of more translucent materials.

Dental implants do not suffer from degradation due to caries. However, they can develop peri-implant disease due to voids that allow oral pathogens to breed and affect adjacent tissues. The screw-in process of implant prosthesis installation can cause misfits at the implant-abutment connection. Besides compromising the mechanical

stability of this joint, misfits also create voids that can also be infected by oral pathogens. The void at the implant-abutment junction is a known risk factor for peri-implant disease. A prosthesis undermined with cement voids could also create an ideal incubator of oral pathogens. From these voids, the oral pathogens could launch a relentless assault against the adjacent tissues and cause the effects we recognize as peri-implant disease. Of course, cement voids can also cause the discoloration of crowns and bridges made of translucent materials.

On a microbiological level, the ability of the bacteria to create peri-implant disease rests with a balance among at least 3 elements including the virulence of the bacterium, the size of the inoculum and the resistance of the host. The bigger the misfit or “void”, the bigger the potential inoculum and the more challenging the infection will be for the host. Of course, patients with a history of periodontal disease would already harbor oral pathogens that have demonstrated their ability to overcome the host’s resistance. Smokers also have a compromised ability to resist the onslaught of their oral microbiota. So, it is no surprise that these groups of patients would be affected more by peri-implant disease when the installation technique leaves voids under the prosthetics, or creates misfits at the implant-abutment junction or leaves excess cement in the subgingival environment. However, we can clean away excess cement, but how can we detect and treat cement voids? This problem would usually require the replacement of the prosthesis.

Prosthesis installation by an intra-oral cementation technique is a method that allows for the optimization of the fit between the dental implant and the abutment. However, this technique can also cause residual excess cement known to contribute to peri-implant disease. Safer intra-oral cementation techniques that can prevent residual subgingival cement have been proposed by the author. (17,18,19,20) Using an intra-oral cementation technique that can cause voids between the retainer and the prosthesis is of great concern, because cement voids can contribute to peri-implant disease in the subgingival environment and bad tastes and smells in the supra-gingival environment.

The group 1 experiments demonstrate that, even under ideal “in vitro” conditions, when an almost vertical force is used to seat a crown, the cement outflow pattern is irregular. If the cement volume used was “just perfect” to fill the cement space, even small imperfections in the margin design might cause some voids at the margin periphery, because a little excess cement volume expressed on one side of the crown would result in an equal volume cement void somewhere else along the margin. On a microscopic level, the 1 micron oral bacterial order of magnitude, even very small voids and excesses might be enough to foster bacterial proliferation and peri-coronal

inflammation. It is just not possible to use a technique that relies on the precise control of cement volume to allow the clinician to achieve an absolutely perfect cement fill under a prosthesis with no excess cement and no cement voids. This is unfortunate.

Cementing crowns into the oral environment can be complicated by contact with adjacent gingiva, tight contacts with adjacent tooth structures and finding the appropriate seating position for the prosthesis. The complexity of this process can increase with the size of the prosthesis being installed, the cooperation of the patient and the clinician's ability to keep a dry field. In addition, some cements are more difficult to handle than others and can have challenging time related restraints. These time related characteristics can affect working time and the time in "gel state" that facilitates removal of excess cement. Further, the cementation process can be rendered a "blind event", when the clinician's hands or patient's anatomy obscures the clinician's sight. So, it might be very difficult to place just enough cement into the prosthesis and cement the prosthesis in at the optimal vertical angle somehow ensure elimination of excess cement and cement voids under the prosthesis.

Fig 1 shows aluminum rods with the 3 margin designs tested including the Tapered Margin, Reverse Margin and the Chamfer Margin. **Fig 2** shows a Tapered Margin rod with a transparent crown filled with pink cement substitute. This cement substitute was chosen so that it would be easier to visualize the pattern of cement flowing out from between the margins of the crowns tested. **Figs 3** shows the irregular pattern of cement expressed when vertical force was used to seat the crown. The crown seems to float on the cement as it is being pressed into place. Even with best efforts, the cement exiting the crown was uneven. Thus when a minimized volume of cement is used to fill the crown, one could expect excess cement exiting from some parts of the crown margin and the likelihood of cement voids in other regions of the crown margin. This could result in a difficult to manage situation for the clinician and future complications for the patient.

The **Figs 4&5** demonstrate the pattern of excess cement extruded from the margins of a crown when an "off centre" force is used to seat a crown. Such an off angled force may be difficult to avoid in a clinical situation due to the above mentioned complexities involved in this intra-oral process. An angled seating force applied on the right marginal ridge of a crown will cause excess cement to be extruded preferentially on the left side. In the case of "just enough cement", we would expect the most excess cement to be extruded from the left margin opposite the applied force. We also would expect there to be the least cement, or the potential for a void to appear under the right side margin. We would also expect a gradation of excess cement volume to cement void on the two

sides of the crown between the between the left and right aspects of the crown. In a clinical situation, this condition would be very difficult to manage. Subgingival residual excess cement that may be difficult to find and voids that are difficult to diagnose and even more difficult to treat.

Note that the Reverse margin design always redirects excess cement in an occlusal direction while the other margin designs direct the cement in the tissue direction. In studies by the author, this margin design is an important part of a cement control system that can reduce the incidence of residual subgingival cement (17,18,19,20) that is a known risk factor for peri-implant disease.(14)

Figs 6,7,8 are experiments based on the “retainer replica” technique developed by Wadhwani and Pineyro (26). In their article, they propose to reduce the volume of excess cement in order to reduce the problem associated with residual subgingival cement. Unfortunately reducing cement volume opens up the problem of creating even more troublesome cement voids under the prostheses. It is often possible to remove excess cement by endoscopic means or after surgical exposure. (14) How does one detect and correct cement voids?

In their article, Wadhwani and Pineyro (26) propose to create a reproducible space for cement, by using Teflon tape as a spacer while they create the retainer replica out of a hard silicone material. However the crown has no built in stops to maintain any cement space. When the Teflon tape is removed, retainer replica will likely obliterate the intended cement space when it is pushed into the cement loaded prosthesis. The cement space is more likely caused by the viscosity of the cement and the pressure used to express excess cement. This is not a precise technique.

Also, when the retainer replica is removed from the intaglio of the prosthesis, the removal force must overcome the suction force created by the cement, between the replica surface and the crown surface. When the replica is pulled out of the prosthesis, the remaining cement pattern inside the crown and on the retainer replica is very irregular in pattern and thickness. **(Fig 6de,7bde)** In all the cases shown, this irregular pattern of cement has a high potential to create air voids between the crown and the retainer. Some of this trapped air may be expelled from the prosthesis during the cementation process and some will remain and may become continuous with the margins of the prosthesis. **(Fig 8,9abc)** A similar technique proposed by Galvan et al. 2016 (28) uses a hard retainer replica to control cement volume. Both of the above cement volume reduction techniques create a situation that has a high risk of creating dangerous cement voids under the prosthesis.

A recent video published by the author (29) shows the formation of voids under a transparent crown cemented into place with Rely X Unicem after using the retainer replica technique (26) mentioned above. In the video, it is clear that air entrapment is a contributor to the formation of cement voids under the crown. After the crown is pushed into place with a finger, removing the seating pressure while the cement is still fluid, allows the cement under the crown to lift the crown up. This apparent lifting of the crown seems to be a result of a pressure increase under the crown caused by the crown seating process. When there is no cement adjacent to the crown, the margins draw in air while the crown lifts. **(Fig 9abcde)** When there is excess cement adjacent to the margin, the margin seems to draw in cement. In the clinical situation it is probably better if there is excess cement adjacent to the margin rather than air and/or tissue fluids. In any case, without excess cement adjacent to the margin, this process can be responsible for the creation of significant voids under the prosthesis and can lead to local oral disease.

It is unfortunate that the cement reduction protocols mentioned in the literature cannot manage excess cement or production of voids effectively. (26,28) The author suggests that sufficient excess cement should be used to ensure absence or reduction of cement voids under the prosthesis and to make the excess cement visible to the clinician for easier detection and removal. It is difficult to control cement flow during intra-oral prosthesis cementation without a good understanding about the fluid dynamics involved in the cementation process. Certainly, abutment designs, prosthesis designs, adjacent gingiva and installation process all have an effect on the flow of cement when placing the prosthesis margins into the subgingival environment. This has been demonstrated in previous research by the author who proposes site specific custom abutment and prosthesis that are “well designed” along with low pressure installation techniques to better control the flow of excess cement and its ultimate removal. The designs and process for intra-oral cementation should follow the principals determined by the “Cement Control System” for the most predictable cement control. (17,18,19,20) As shown in a recent video publication, this can all be done without creating dangerous cement voids at the margins of the crowns and bridges. (29) Indeed these abutment-prosthesis designs recognize how excess cement can be made to flow out and away from tissues and how excess cement sticks to itself and can make it easier to locate and clean away.

The safer intra-oral cementation technique promises to reduce caries and periodontal disease for prosthetics installed onto natural teeth. The safer intra-oral cementation technique may reduce peri-implant disease and retainer failure by 60%, as extrapolated

from the results of Wilson 2009. (14) This should be welcome news to the whole dental industry and the patients that it serves.

The implant industry, in particular, is beginning to experience a backlash due to the high rates of peri-implant disease reported by some authors. A review by Derks et al (4) published in 2016 was sent to all the dentists in Ontario Canada by the Royal College of Dental Surgeons of Ontario. This was done for educational purposes. This particular review (4) investigates the prevalence of peri-implantitis in a Swedish Group of patients that received treatment under their national health program. Clinicians deciphering the implications of the presented results, might wish to be alerted to the fact that this patient group may well have been subject to a grossly inadequate professional maintenance care. Indeed, it would be helpful if more details regarding the nature of the professional maintenance protocol were provided, so that clinicians could better understand the implications of this research. (31) According to a survey of periodontists that was published in the May 2016 issue of the Journal of Periodontology, “Most participants believed that the best maintenance frequency after treatment for peri-implantitis was every 3 months”. (33) According to the Derks et al. article,(4) their heavily restored group of patients with an average of 4 implants each, 20% smokers and large periodontitis and peri-implant disease prevalence, were maintained with an annual recall program (80%) and about 20% of their sample was seen even less frequently. In a previous article by this Swedish group, (2,3) they suggest that early treatment of mucositis may be deemed a preventative measure for reducing its progression to peri-implantitis. I agree, that might have helped reduce the high incidence of peri-implantitis in this group of patients. Perhaps even a better idea would be to actually prevent mucositis by reducing the impact of two known risk factors that contribute to peri-implant disease. Why not use prosthesis installation techniques that optimize the fit of the implant-abutment junction and reduce the incidence of residual subgingival cement. The author, Dr. Svoboda, proposes such techniques. (17-20,29,30,32)

It is important to note that almost 80 percent of the implants assessed in this review had their prosthetics installed by the intra-oral “screw-in” technique. Some dentists choose to believe that peri-implantitis is largely a problem related to residual subgingival cement that may result from the intra-oral cementation process. Yes, residual subgingival cement is a risk factor for peri-implant disease (14) but I suspect the implant-abutment misfit inherent to the screw-in technique is a major contributor to the peri-implant disease around implants installed by the screw-in technique. This is consistent with a 15 times higher incidence of peri-implantitis in the patient group with 4 or more dental implants. They are more likely to have multiple unit prosthetics that increase the risk of a misfit at the implant-abutment junction, increase the use of cantilevers and for screw

access, increase the problem of inaccessibility for proper hygiene by the patient and the professional caregiver. The big problem is, once you create an implant-abutment misfit "How do you correct it?" At least, if the clinician does not choose to use techniques that prevent residual excess cement, when detected by endoscopic or surgical means, it can be removed and the clinician can expect a good rate of problem resolution. (14)

Conclusion:

It appears that intra-oral cementation is a necessary process for installing prosthetics onto natural teeth and onto dental implants. For implant prosthetics it is a necessary step for optimizing the fit of the implant-abutment connection. (18,19) It would be a benefit to make this process as safe as possible for patients requiring this service.

For safer cemented prosthetics, the author suggests filling the intaglio surface of the prosthesis with cement in such a way as to prevent air entrapment and to ensure optimum retention of the prosthesis. Expressing excess cement from around the entire margin of the prosthesis helps to prevent the formation of dangerous cement voids under the prosthesis. When the prosthesis is held in place as the cement sets, it can prevent the prosthesis from lifting and drawing adjacent air, tissue fluids or indeed cement into the margins of the prosthesis. Besides reducing the need to adjust high occlusions, this technique is more likely to prevent cement voids that can foster the ingress of pathogens into the margins. To control excess cement and prevent the occurrence of residual subgingival cement, prosthesis designs should be sensitive to the effects of gingival (Gingival Effects), margin design and seating pressure on cement flow. (19) Visible excess cement adjacent to the margins of the prosthesis can prevent cement voids and is usually much easier for the clinician to detect and clean away. Controlling excess cement and preventing cement voids under the prosthesis should make all intra-oral cementation process safer.

For prosthetics that are installed onto dental implants, in addition to the above recommendations, the author proposes the use of a technique that includes the use of "well designed custom abutments". These well designed custom abutments can optimize the implant-abutment connection and create a relative barrier against tissue penetration by excess cement. The effectiveness of the "well designed custom abutment" is enhanced by a "well designed" prosthesis that facilitates the flow of excess cement out of the tissue spaces and thus counteracts the potentially damaging Gingival Effects. (17) The "Cement Control System", developed by the author, and its variations are robust, and also offer benefit to those clinicians who wish to install implant prosthetics by a modified the screw-in technique. (32) Simply put, the technique allows for the optimization of the implant-abutment connection and the reduction of subgingival

cement, and thus helps to prevent associated peri-implant disease. In light of the growing evidence that our installation techniques may be contributing to the high peri-implant disease rates experienced by our patients, it should be welcome news to all that a system of safer installation may have a significant positive effect at reducing peri-implant disease rates. Complications are expensive for both the clinicians and the patients they treat.

To prevent the occurrence of cement voids under a prosthesis, the author suggests some ways to mitigate this serious and probably common problem. 1) Load cement into the occlusal part of the intaglio of the prosthesis to minimize the trapping of air as the prosthesis is being pushed into place. Avoid techniques that cause an irregular distribution of cement inside the prosthesis prior to cementation intra-orally. These techniques may cause unnecessary air entrapment under the prosthesis.
2) Load enough excess cement volume into the prosthesis to be sure to have excess cement expressed around the entire periphery of the prosthesis. It is best to have excess cement in the sulcus to allow the excess cement to re-enter the crown preferentially, rather than air or tissue fluids or other troublesome materials. Avoid the use of techniques that minimize cement volume.
3) Use intermittent super low pressure on the prosthesis during the cementation process to dissipate pressure that builds up under the prosthesis as it is being pushed into place.
4) Hold the prosthesis in place until the cement sets enough to prevent it from lifting the prosthesis when the seating pressure used to insert the prosthesis is removed.
5) Clean away excess once the prosthesis is stabilized. The safer cementation process works best with the Cement Control System developed by the author, because that system controls the location of cement for easier detection and removal.

The safer cementation protocol described above promises to significantly reduce the incidence of iatrogenic complications related to current prosthesis installation techniques.

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