Dental Implant Prosthetics: Achieving Retrievability and Reducing Treatment Complications by using a Modified Installation Technique.

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Abstract: Many clinicians prefer to install the implant prosthetics by the screw-in method, because they believe that this method of installation allows for prosthesis retrievability. However, retrievability does not result from the prosthesis installation method, but relates to "Retrievability Features" created by the implant surgeon and enhanced by the implant manufactures. These features include placing implants in a position that allows for a working path of insertion and a desirable abutment-screw access-hole location. Implant manufacturers have created aids, such as multi-unit abutments and special abutment screws that build some tolerance into the abutment-prosthesis system, for restoring implants in non-optimal positions. Unfortunately, these features do not mitigate the major cause of complications inherent to the screw-in prosthesis installation technique, the implant-abutment misfit. A review of the current literature indicates that complications arising from implant treatment involving fixed prosthetics are 30% for mucositis and 15% for peri-implantitis. This results in an implant failure rate of 4% over 5 years and 8% over 10 years. These complications require treatment and can be expensive for both the patient and dentist. The reviews were unable to discern differences in complications related to the method of prosthesis installation. However, it appears that prosthesis installation methods may be stressing the biological and mechanical systems in different ways. The screw-in installation method includes the extra-oral cementation of the abutment-prosthesis complex, on a model of the mouth. The inaccuracy of this model contributes to the inaccuracy of the abutment-prosthesis assembly. This causes stress and misfits at the implant-abutment connection when it is installed onto implants inside the mouth. Such misfits can lead to mechanical instability of the implant-abutment connection and also renders adjacent tissues susceptible to trauma from joint movement and assault by oral pathogens. The implant-abutment connection can be optimized when the abutments are individually installed into the oral environment and then attached to the prosthesis by means of intra-oral cementation. However, that process in turn, appears to cause another biological problem, due to the advent of residual subgingival cement. Dr. Svoboda has discovered new information about the process of intra-oral cementation that can help prevent this problem. His cement control system includes specific design elements for abutments and their complimentary prosthetics, and involves the use of super low installation pressures during the process of intra-oral cementation. Once the

abovementioned retrievability features are in place, the author proposes the “Svoboda Modification” or its “Simplified” version, to both control excess cement and optimize the implant-abutment connection. These proposed modifications are relevant to implant prosthetics that are to be installed by the screw-in method. They have the potential to reduce implant complications by 60%. This estimate has been extrapolated from the study of TG Wilson (J Periodontol 2009;80:1388).

Introduction: Implant treatment has greatly improved the level of care offered to patients. According to Misch 2015, implant retained prosthetics are usually installed by a means of intra-oral cementation or by a screw-in method, that involves the extra-oral cementation of the abutment-prosthesis complex. (1,2) The screw-in technique is commonly referred to as retrievable. It is implied that this installation process allows the prosthesis to be removed from the mouth and reinstalled without any critical damage to the prosthesis. It also implies that the prosthesis that is cemented intra-orally is not easily retrievable and that it would have to be critically damaged during its removal.

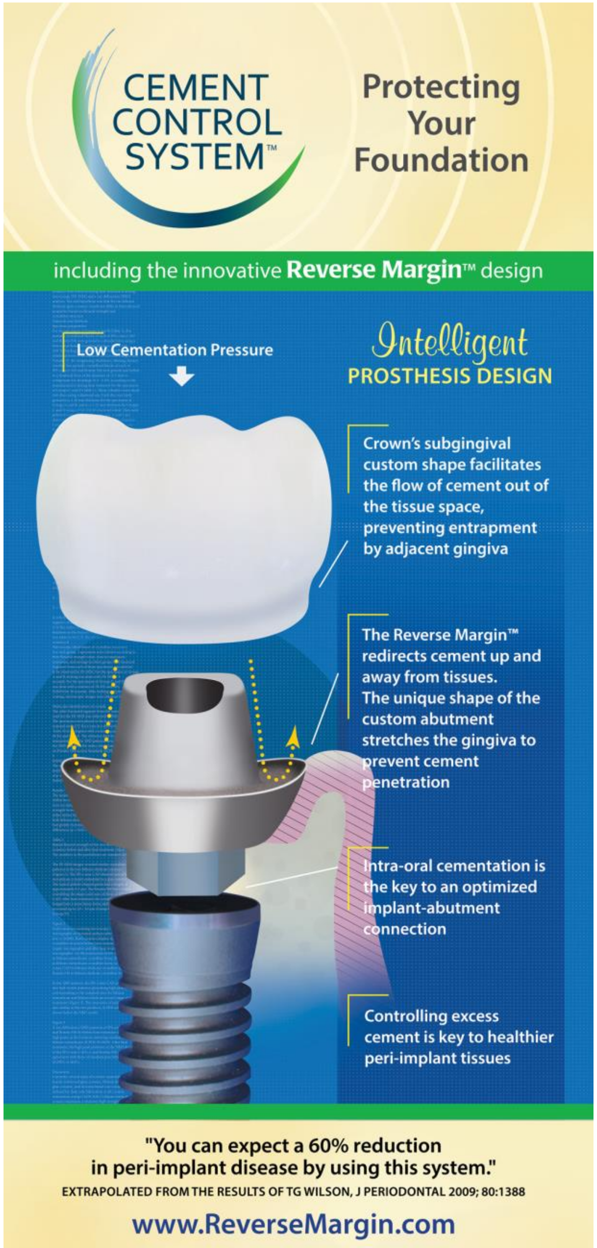
No differences in complication and failure rates have been found in reviews that compare the two installation systems. (3-6) The above reviews indicate that 31- 33% of the fixed prostheses retained by dental implants are associated with mucositis, 10-16% peri-implantitis (3,4) and that the survival rates of the implants are about 96% over 5 years and 92% over 10 years. (5,6) The biological complications of treatment manifest themselves as peri-implant inflammation, exudate, loss of gingiva and supporting hard tissues. All these complications require treatment (1-7) and can cause a “less than happy” experience for the patient and the dentist. Yes, treatment complications can be emotionally and financially taxing for all involved. The question is, “Can we reduce these complications?”

If we assume that all other pertinent variables have been controlled by the magnitude of the above reviews, it stands to reason that we should look to the differences between these two installation systems. In this way, we can to identify the weaknesses contributing to their possible failure. Both systems involve abutment screws that attach abutments to dental implants already in the oral environment, and both systems retain and support a prosthesis that is cemented onto those abutments.

What is the main difference between the two installation systems? The main difference appears to be related to where the prosthesis is cemented to its’ abutment or abutments. In a traditional setting, the screwed-in prosthesis is assembled on a model that is not a precise representation of the mouth. This extra-oral assembly of the abutment-prosthesis complex forms an imprecise rigid structure that, when transferred to the mouth, causes a misfit at the implant-abutment junction. This misfit at the implant-abutment joint is not optimized for stability and is also more susceptible to invasion by oral pathogens. This can create problems for the patient. These can include loose and broken screws, foul odour and taste, and the abovementioned complications including mucositis, peri-implantitis and implant failure. These complications can be difficult to mitigate because the implant-abutment misfit cannot be easily repaired. (8-11) In addition, one must consider the possibility that uneven loading of an ill-fitting connection by the abutment screw tightening process and /or intra-oral function could also cause damage to the adjoining components? It is possible to replace a damaged abutment, but how does one repair a damaged implant top? **In conclusion, the major weakness of the screw-in prosthesis technique, appears to rest with a poor implant-abutment connection that is difficult to correct.**

It is widely accepted that intra-oral cementation of the implant prosthesis allows the clinician to optimize the fit of the implant-abutment connection (1) but adds a problem related to the incidence of residual subgingival cement. (11-14) Residual subgingival cement is a known risk factor for “peri-implant disease”. Peri-implant disease is a term used by Wilson (2009) to describe mucositis and/or peri-implantitis. He demonstrated that residual subgingival cement was associated with 81% of peri-implant disease cases he found among a group of cemented single tooth replacements. He also found that its removal could eliminate peri-implant disease in 74% of these cases. (14) On the basis of this study, a clinician could expect to reduce peri-implant disease by 60% by preventing the occurrence of residual subgingival cement. Current research has identified new information about the process of intra-oral prosthesis cementation that could prevent the occurrence of residual subgingival cement. (12,13) **In conclusion, while intra-oral cementation can optimize the implant-abutment connection, the major weakness of this process appears to be the control of excess cement. New information about the process of intra-oral cementation promises effective management of excess cement and thus reduces the current barrier to its use for prosthesis installation.**

Svoboda has identified the effects of margin design and adjacent gingiva on the flow of excess cement. (15-18) He found that tissue-facing margins eject excess cement towards and into the tissues, while an inflected margin design could redirect the cement away from the tissues. He called this inflected margin design the “Reverse Margin”. When margins were placed into the subgingival environment, he found that gingiva could form a seal with the prosthesis, restrict the flow of excess cement out of the subgingival environment and thus cause excess cement to be projected deep into the tissues. He named this undesirable effect the “Gingival Effects”. He further identified 4 components of the Gingiva Effects that he named the Deflection Effect, the Eddy Effect, the Plunger Effect and the Bellows Effect. Dr. Svoboda found that the Gingival Effects could overcome any margin design and that their effects could be mitigated by abutment and prosthesis design, and alterations in the prosthesis installation system.



He proposes the "Cement Control System" to prevent the occurrence of residual subgingival cement. He feels that this Cement Control System and supporting work, should be should be understood by all those that wish to install prosthetics into the oral environment. (18-21)

New Technique: To create an optimized treatment plan the dentist must weigh the advantages and disadvantages related to many available treatment approaches. These include the needs of the patient and their own set of skills and support. To some dentists, easy retrievability of the prosthesis appears to be of paramount importance.

Some clinicians prefer to install the implant prosthetics by the screw-in method, because they believe that this method of installation allows for prosthesis retrievability. Dr. Svoboda proposes that prosthesis retrievability does not result from the installation method, but relates to "Retrievability Features" created by the implant surgeon and enhanced by the implant manufactures. The surgery related features include placing implants in a position that allows for a working path of insertion and a desirable abutment-screw access-hole location. Surgical stents and site development procedures are often used to facilitate optimized implant positions for prosthesis retrievability. The implant manufacturers have created multi-unit abutments and special abutment screws, like the angled screw channel abutment (ASC) from www.NobelBiocare.com, to build some tolerance into the abutment-prosthesis system for restoring implants in non-optimal positions.

It is important to realize that the Retrievability Features are not confined to either of the major prosthesis installation methods mentioned above. They can be used as part of the treatment process, whether the clinician wishes to install the prosthesis by the cement-in or screw-in the technique. Further, none of the Retrievability Features actually solve the significant problems associated with the misfit of the implant-abutment connection caused by the conventional screw-in prosthesis installation technique.

However, combining the retrievability features with intra-oral cementation and/or the screw-in prosthesis installation technique presents the clinician with a new opportunity to optimize the implant-abutment connection and control residual subgingival cement. This combination of techniques can be referred to as the “Svoboda Modification”. It can be expected to result in a reduction in the existing complication rate similar to that already discussed for intra-oral cementation using the cement control system. This would indeed be welcome news to those patients and clinicians struggling with the negative consequences of treatment complications and failure.

The Svoboda Modification assumes that the Retrievability Features are in place. To implement the Svoboda Modification, the clinician would add the following steps: 1) to optimize the implant-abutment connection, the clinician would install the abutments into the mouth individually and torque them into place according to manufacturers recommended torque values. Then the dentist would pack the abutment screw access channel of each abutment with sterilized Teflon tape (Plumbers’ Tape) to prevent cement from entering it 2) the dental laboratory would deliver the fixed prosthesis with adequate cement space, 80 - 100 microns would usually be sufficient, and with the abutment screw access holes closed with an acrylic plugs 3) the clinician would try-in, adjust and then cement the optimized prosthesis into place. The optimized prosthesis would fit passively onto the already installed abutments. 4) the clinician would then remove the acrylic plugs, the Teflon tape, the abutment retention screws and the prosthesis, and then check the gingiva and prosthesis for excess cement and clean it away 5) then the clinician would use new screws and install the prosthesis back into the mouth according to the manufactures directions, fill the access chambers with Teflon tape and fill the occlusal portion of the access hole with an acrylic plug. The patient now has a retrievable prosthesis that looks like previous ones, but now is now much better. It is better because the clinician has optimized the implant-abutment connection and has thus reduced the possibility of idiopathic complications related to misfits at the implant-abutment connection.

Further, if the clinician wishes to eliminate the screw access holes and the annoying problems related to them, they can simply eliminate the time consuming steps 2), 4) and

5) from the above Svoboda Modification, and simply cement the prosthesis into the mouth using the feature and technique of the Cement Control System. This system is already designed to optimize the implant-abutment connection and prevent the occurrence of residual subgingival cement. To make it easier to locate the screw access channels in the future, the clinician could have their lab technician mark the occlusal access positions of the screw access channels and/or record their position prior to cementation of the prosthesis. It is usually not difficult to open the marked access channels with a course round diamond, on a "need to do so" basis. However, the screw access holes may never need to be opened, because the clinician has already controlled excess cement and optimized the fit of the implant-abutment connection. This simplified process could be called the "**Simplified Svoboda Modification**" as it reduces steps and complications. Using this technique, the installed prosthesis is still completely retrievable and promises to reduce those bad days for clinicians and their patients dealing with idiopathic complications.

Discussion: The cementation part of the above described process is based on the work previously published by the author and described as the Cement Control System. (18-21) His publications describe the recommended process of implant prosthesis installation with the specific design features that facilitate cement control. The main aspects of the process include, installing the abutments individually to optimize their fit, trying-in the prosthesis to ensure a passive optimized fit, and cementing it in with an appropriate cement while using super low cementation pressures. Indeed, use of cementation pressures in the order of 100-150 grams (21), rather than 2,500 grams and 40,000 grams or more (22,23), supports the concept of better cement control.

Dr. Svoboda would like to acknowledge that there is a system of implant prosthesis installation referred to as the "Screwmentation Technique" (www.Dentaltown.com). I was able to use the Google search engine to retrieve an article written by Dr. J Scott (2014) about this technique (24) and another by Dr. B Birdi (2015) (25). This technique appears to have some similarity to the above mentioned Svoboda Modification. Unfortunately, the Screwmentation technique involves the assembly of the implant-abutment unit outside the mouth and thus suffers from the same problems as the conventional screwed-in prosthetics. It has the probability of creating a misfit at the implant-abutment connection due to model and prosthesis inaccuracy. Nonetheless, I find it is a progressive concept that attempts to mitigate a problem of prosthesis misfit due to prosthesis inaccuracy and tight contacts.

M. Rajan and R. Gunaseelan (2004) proposed a technique that is similar to the Svoboda Modification. (26) There were a few differences. 1) They did not fully torque down their abutment screws prior to intra-oral cementation. The abutment-prosthesis complex can upright itself while it seats against the implant on final torqueing of the abutment screw, and thus affect the fit of the contacts with adjacent teeth. 2) They did not close off the screw access holes prior to prosthesis cementation. This would have altered their control over the cementation process, as they would not have been able to control their cementation pressure to ensure the elimination of cement voids and control pressure of cement exiting the prosthesis. 3) They presumed that there were cemented cases that they did not need to retrieve to clean away subgingival cement. As they were not yet privy to the "Gingival Effects" and the work of Tomas Linkevicius (11), they might not have been able to determine when they should remove the prosthesis for residual cement removal. In any case, they appear to have been on the right track and were certainly concerned about removal of residual subgingival cement and thus reduce its damaging effects.

So what has made this new treatment approach, both possible and practical?
1) Dental Milling Technologies, CAD/CAM based, have allowed the dental industry to create increasingly precise implant-abutment components. Milled components can be made to fit better against each other and thus be more stable and resist bacterial penetration. **Beware** of older technologies that require a casting process that can distort the milled implant-abutment connection. The UCLA bases are precision milled, but the casting process can damage their fit by temperature related distortion and mechanical removal of investment material. A bad implant-abutment fit can lead to increased complications. (25)

2) The dental milling industry can also create custom "site specific" abutments and prosthetics that have new design features shown to enhance cement control during the process of intra-oral cementation. This process is cost effective and can have high value for the clinician and patient. **Beware** of older margin designs that direct excess cement into the tissues. **Beware** of stock abutments, because they usually require prosthesis margin designs and emergence profiles can exacerbate the problem of injecting excess cement into the peri-implant tissues due to the Gingival Effects". This cement can be difficult to detect and remove. (11,14-18)

3) Milled zirconia and other monolithic crowns and bridges can be esthetic and can be more resistant to failure due to porcelain fracture. Indeed, newer "more translucent zirconia materials" promise to be more esthetic and thus he need for porcelain veneering even further. Less need to remove, repair and replace prosthetics due to porcelain failure is nice. Less need for retrievability is also nice because retrievability features can be expensive to create. Provision of access or potential access to abutment screws for the purpose of re-tightening, does not necessarily require a fully retrievable prosthesis. Optimization of the implant-abutment connection during the prosthesis installation process should already reduce the incidence of screw loosening and thus the need for screw access.

4) Newer cements can have higher compressive strengths, are fluid and have a longer, more controlled working time. Their cleanup can also be easy when they are removed during their “gel state”. Further, they are not subject to “washout” at the margins. (27) Thus, together with the new cement control designs and techniques, the clinician can considerably reduce the forces involved during the intra-oral installation process. Less force means more control over the flow of excess cement (17-20) **Beware** of old habits and old prosthesis designs that require the clinician to compress tissues and otherwise use high pressure intra-oral cementation techniques. This exacerbates problems related to poor cement control.

5) It is the author’s opinion, that in spite of best efforts, it will be some time before the dental industry will be capable of making implant prosthetics sufficiently precise to avoid the need for cement. (29,30) Indeed, in 1985, PI Branemark mused about creating a fit between components that should be within10 microns of their target. (31) This can already be considered “pretty sloppy” if one considers that oral pathogens can be mobile and are about 1 micron in diameter. Together with errors from impressions, models, scans of models, and analogues~~,~~ we still accept an error of 100-150 microns as clinically acceptable. (30) But is it? I feel that the best the dentist can do at the present time, is buy components that fit as precisely as possible and ensure that their installation technique does not make the fit between components worse. Then dentists need to rely upon the patient’s immune system and maintenance to take care of a reduced bacterial load. Ideally, the implant industry will continue to make their components fit better, be more resistant to occlusal forces and at least seal connections between components against bacterial invasion. All of that lies in the future.

In Conclusion: The author would like to encourage the clinicians who like to work with retrievable prosthetics, to consider and then integrate the above “Svoboda Modification or its’ Simplified Version” into their implant prosthesis installation system. Avoiding complications for the patient and the clinician is a worthy goal. A possible reduction of these complications by perhaps 60% would be welcome news for all involved.

The author encourages further communication about the above ideas. Email Dr. Emil Svoboda at drsvoboda@rogers.com and he will be happy to help colleagues integrate these concepts into their workflow. More Information about this and supporting work is available at www.ReversMargin.com.

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