Preventing Peri-implant Disease by Safer Prosthesis Installation: Managing the Macrogap and Residual Subgingival Cement.

Emil LA Svoboda PhD, DDS

November 6, 2017

Dental implants are used in dentistry as tooth root replacements that can be used to retain replacement teeth. Dental implant abutments are used to connect dental implants to the dental prosthesis. The implant-abutment connection is often located in the deep subgingival space, close to the alveolar bone adjacent to the dental implant. There is much research that discusses the importance of the fit of the implant-abutment connection. Indeed, the fit of this joint is critical to its stability during oral function and its ability to prevent penetration by oral pathogens. Poor implant abutment fit is a known risk factor for peri-implant disease. The machines that are used to make implants and abutments can work at an accuracy of ±5 microns and better.[1] The inaccuracy of fit of implant components, that is contributed by the machined parts can referred to as the implant-abutment **microgap**.

The **Canadian Government classifies dental abutments as Class 3 implantable devices**, like dental implants. They have established fit and stability criteria for implant-abutment connections, for manufacturers that wish to sell these implantable products in Canada. These criteria are intended to ensure a level of fit and stability of the implant-abutment connection, that is intended to enhance the safety of implant based treatment for patients.

Some of the literature that discusses the implant-abutment connection, describes the fit of components in vitro, under ideal connection conditions. Indeed, the manufacturer's research that describes the behavior of the implant-abutment joint, also assumes that the fit of the implant-abutment joint has been optimized according to the manufacturer's specifications. It follows that, if dentists can install the abutments into the mouths of their patients according to manufacturer's specifications, the dentist and patient could expect the joint to behave as predicted by the manufacturer's research. Optimizing the fit of this joint would also support the intended goals of Government regulation for implantable devices.

There are two main systems that are used to install implant prosthetics into the mouths of patients. They have some similarities (Table 1) and some differences (Table 2). Their differences create their unique advantages and disadvantages. Four large reviews that considered the rates of peri-implant disease attributable to these two installation techniques found "no difference" between the two techniques[2-5].

Table 1	How the Prosthesis Installation Systems are Similar		
		Screw-in	Cement-in
1	Prosthesis Made to Fit Model of Mouth	Y	Y
2	Abutment-Prosthesis Complex Attached to Implant by Abutment Screw	Y	Y
3	Can Be Made to be Retrievable by Unscrewing Abutment Screw(s)*	Y	Y
4	Screw Access Holes Closed After Installation*	Y	Y/N

*ELA Svoboda[6]

Almost all dental prostheses, that are installed into the mouth of patients, are made on models of the mouth.(Table 1, row 1) These models are created from physical or digital impressions of the mouth, made by the clinician. Model accuracy is dependent on the accuracy of all the processes used to create them. The "accepted range of accuracy" of a dental model is about ±150 microns[7].

The accuracy of an individual model is difficult for the laboratory or clinician to judge. However, the clinician installing the prosthesis into the mouth must usually adjust the prosthesis to fit. Why does the clinician need to adjust fit, contacts and occlusion when installing a prosthesis? Why does the dentist who is installing the prosthesis have good days and bad days? Why is the intra-oral prosthesis fit so variable? The answers to these questions are an "all too common" confirmation, that dental models and thus their related prosthetics are also inaccurate. If dental models were accurate, the dental prosthetics made on them could also be accurate, and the need for time-consuming adjustments to the prosthesis during intra-oral installation would not be necessary.

The **implant-abutment misfit is inherent to the screw-in technique,** and results from dental model error and installation protocol. (Table 2, rows 1-3) This misfit has been called the **macrogap**[8] and can also be called the big gap. A recent review of the macrogap[9] reported that "it is noteworthy that the misfit values at the clinical follow-up ranged between 95 and 232 μm". **This macrogap is 20 to 50 times the size of the microgap caused by the manufacturing process!** This size of implant-abutment misfit would not likely be consistent with the intention of current Government regulations. This range of misfit could be difficult to justify to a patient with implant-treatment related complications. Shouldn't clinicians install implant components according to factory specifications?

Table 2	How the Prosthesis Installation Systems are Different			
		Screw-in	Cement-in	Effects
1	Abutment(s) Affixed to Prosthesis on Model	Y	N	NEG
2	Constrained Abutment-Prosthesis Complex Installed into Mouth	Y	N	NEG
3	Implant-Abutment Fit/Misfit Determined by Model Accuracy**	Y	N	NEG
4	Technique Related Cantilevers for Screw Access	Y	N	NEG
5	Technique Related Grafting to Allow for Upright and Parallel Implants	Y	N	NEG
6	Each Abutment Attached to Each Implant Independent of Prosthesis	N	Y	POS
7	Implant-Abutment Fit is Determined by Manufacturers Specifications***	N	Y	POS
8	Prosthesis Adjusted and Joined to Installed Abutment(s)	N	Y	POS
9	Cement Space allows for some Tolerance of Fit During Installation	N	Y	POS
10	Passive Implant-Abutment-Prosthesis Connections	N	Y	POS
12	Possible Residual Subgingival Cement Related to Old Techniques****	N	Y	NEG

**The Screw-in Technique makes it very difficult for the clinician to ensure an implant-abutment fit according to the Manufacturer's Specifications. Thus, the research done to describe the behavior of this joint during function does not apply, and it is difficult to predict the behavior of this connection in vivo.
***The Cement-in Technique allows the clinician to install abutment(s) according to Manufacturer's Specifications. The proposed Safer Intra-oral Cementation protocol is New and will be described Below.
****The Old Techniques terminology applies to intra-oral cementation techniques that are not sensitive to the Gingival Effects as described by ELA Svoboda[10] and that are designed to prevent the advent of residual subgingival cement.

The screw-in installation technique dictates that the abutments are rigidly joined to the prosthesis on the inaccurate model, prior to their delivery to the dentist. Thus, the parts of the abutments that are made to fit the dental implants are constrained by the prosthesis into an inaccurate position. When the clinician installs the abutment-prosthesis complex into the mouth, the abutments are unable to make an optimized connection with the dental implants. (Table 2, rows 1 -3) This installation technique does not allow the dentist to install the abutments according to manufacturer's specifications. The manufacture's research therefore cannot predict the performance of those misfit connections under function, and thus the patient

is not protected by the Government regulations that specify the nature of this fit. This is a "**Macro-problem**" because the patient is exposed to risk of implant treatment complications!

The group of patients that seem to be particularly sensitive to this macrogap risk factor are those patients that have a history of periodontitis[11]. Also at risk are those who have 4 or more implants attached to a prosthesis. Multiple unit prosthetics exacerbate the misfit problem, and this group has been shown to experience 15 times the rate of peri-implantitis experienced by patients that have received implant retained prosthetics with 3 or less joined implants[12]. Indeed, the RCDSO sent all dentists in Ontario a copy of this article, to share their concern with its findings.

Table 2, rows 5 and 6 mentions technique related cantilevers and additional grafting that may be necessary to allow a prosthesis to be installed by the screw-in technique, and to make the prosthesis retrievable. These cantilevers can place extra-stress onto misfit implant-abutment connections and can make the peri-prothesis tissues difficult to maintain and keep clean. These are both known risk factors for peri-implant disease[11]. Technique related grafting adds the extra-expense and risks associated with that process. These problems may be difficult to minimize, but an optimized implant-abutment connection may be more stable under load, than a misfit implant-abutment connection. The above "screw-in prosthesis installation protocol" is widely used in Canada and in the rest of the world. Fortunately, this problem of the technique related implant-abutment misfit can be prevented.

Dr. Svoboda has proposed some modifications to the existing screw-in prosthesis installation technique that can allow the clinician to optimize the implant-abutment connections[6]. It requires that the abutments "not be joined to the prosthesis on the model", and that an intra-oral cementation step be added to the prosthesis installation process. Table 2, rows 5 to 9 is a list of how the intra-oral cementation technique differs from the screw-in technique, and how this technique can optimize the implant-abutment connection. Indeed, it shows how components of the cement-in technique allows the clinician to comply with the manufacturer's specifications for the implant-abutment connection. However, current intra-oral cementation protocols are insensitive to the Gingival Effects, as described by Svoboda[10], and thus could cause the advent of residual subgingival cement (Table 2, row 12). It is also a known risk factor for peri-implant disease[13].

If it is not desirable to place the prosthesis margins at or above the gingiva, Dr. Svoboda proposes a new safer intra-oral cementation technique that uses "well designed site specific custom abutments and prostheses" that are sensitive to the Gingival Effects. These intelligent designs, and his specific cementation process, allows the clinician, to not only optimized the implant-abutment connection, but to also control the flow of excess cement and prevent the advent of residual subgingival cement. Thus, extrapolated from the results of Wilson 2009[13], peri-implant disease attributable to the implant-abutment misfit and residual subgingival cement could be prevented, and that could reduce peri-implant disease by 60%. Reducing peri-implant disease by 60% would be a welcome development for dentists and the patients they treat. Reducing the prevalence of peri-implant disease would be consistent with the purpose of the RCDSO.

About the Author: Dr. Emil LA Svoboda earned his BSc, PhD and DDS at the University of Toronto. He has earned Fellowship status from the Academy of General Dentistry (www.AGD.org), is an Honored Fellow of the American Academy of Implant Dentistry (www.AAID.com) and is a Diplomate of the American Board of Oral Implantology/Implant Dentistry (www.ABOI.org). He has placed and restored thousands of dental implants for his patients and those patients referred to him by colleagues. He has restored over 600 dental implants according to his safer installation protocols mentioned above, and has

lectured about his work in Etobicoke, Mississauga, Waterloo, Vancouver, Boston, Las Vegas, Chicago and Orlando. He was awarded with the ODA Award of Merit for his contributions to organized dentistry. His work on the Gingival Effects[10] and his work on Prosthesis Retrievability[6] has earned him first place in separate table presentation competitions in Orlando and Vancouver. Dr. Svoboda welcomes your questions at drsvoboda@rogers.com and would like to help colleagues integrate his safer installation protocols into their office routines. “An ounce of prevention is worth a pound of cure”, Benjamin Franklin. More information is available at www.ReverseMargin.com.

Dr. Svoboda wishes to thank Milan Jovanovic RDT of Diamond Dental Studio, a full service Dental Laboratory, for his help in making the “well designed custom abutments and prosthetics” for his research and for his patients. These designs are sensitive to the Gingival Effects and have been shown to be an important part of the process that is able to prevent the advent of Residual Subgingival Cement. Milan can be reached at (905)866-6866 and at info@diamonddentalstudio.com.

References

1 ELA Svoboda and Milan Jovanovic (RDT) went to the IDS Meeting in Cologne Germany in 2017 and were able to locate many reasonably priced machines that claimed capability to manufacture parts at an accuracy of ± 5 microns.
2 MA Atieh et al. The Frequency of Peri-implant diseases: A systemic review and meta-analyses. J Periodontol 2013:84(11):1586-1598
3 DM Daubert et al. Prevalence and predictive factors for peri-implant disease and implant failure: a cross-sectional analyses. J Periodontol 2015:86(3): 337
4 S Sherif et al. A Systematic Review of Screw- versus Cement-Retained Implant Supported Fixed Restorations. J of Prosthodontics 2014 (23)1-9
5 JG Whittneben et al. Clinical Performance of Screw- Versus Cement Retained Fixed Implant-Supported Reconstructions: A Systemic Review. The Int J Oral Maxillofac Implants; 2014:29(Suppl):84-98.
6 ELA Svoboda. Dental Implant Prosthetics: Achieving Retrievability and Reducing Treatment Complications by using a Modified Installation Technique. Oral Health October 2016:8-20
7 Review: Passive Fit in Screw Retained Multi-unit Implant Prosthesis Understanding and Achieving: A Review of the Literature. M.M.Buzaya and N.B. Yunus. J Indian Prosthodont Soc. 2014, Mar;14(1):16-23
8 S Froum. Top factors leading to dental implant abutment/implant fixture misfit: The dreaded microgap. Perio-Implant Advisory, Feb 6, 2017
9 J Katsoulis et al. Misfit of implant prostheses and its impact on clinical outcomes. Definition, assessment and a systematic review of the literature. Eur J Oral Implantol 2017;10(Suppl1):121–138
10 ELA Svoboda. Controlling Excess Cement During the Process of Intra-oral Prosthesis Cementation: Overcoming the Gingival Effects. OralHealth Oct 2015:52-66
11 M Nobre et al (including Paulo Malo). Attributable fractions, modifiable risk factors and risk stratification using a risk score for peri-implant pathology. Jan 2017 Journal of Prosthodontic Research, Vol 61:1;43-53
12 Derks et al. Effectiveness of Implant Therapy Analyzed in a Swedish Population: Prevalence of Peri-implantitis. J Dental Research, 2016 Vol 95(1):43-49 (588 patients with 2,277 implants)
13 TG Wilson Jr. The Positive Relationship Between Excess Cement and Peri-implant Disease: A Prospective Clinical Endoscopic Study. J. Periodont 2009;1388