The Reverse Margin™ System Design and How it Makes Implant Treatment Better

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Introduction: The Reverse Margin System (RMS) designs satisfy the need to tolerate the three-dimensional errors inherent to prosthesis installation safely. The root causes of these errors include those intrinsic to the indirect production of the prosthesis called Prosthesis Dimensional Error (PDE), the need for the dentist to manage the multiple Incongruent Paths of Insertion (ICPOI) determined by hard and soft tissues, dental implants, abutment connectors, and prosthetic connectors, and the need to manage the Tissue Effects (TE); the Resistance to Displacement Effects (RTDE) and the Gingival Effects (GE).[1,2] The oral environment is complex, and the TE can frustrate the efforts of the dentist to place implants ideally and to optimally connect attachment parts and the prosthesis. The root causes of mechanical problems related to prosthesis installation are also responsible for multiple risk factors for peri-implant disease. While the oral microbes causing peri-implant disease are often difficult to see, their destructive effects on tissues are easy to see.

The RMS design features and installation protocols were developed to prevent implant-abutment misfits, abutment-prosthesis misfits, open and overhanging margins, and subgingival cement. These are well-documented risk factors for peri-implant disease and its dire consequences.[3] Complications and failure of dental implants are costly for both patients and their dentists. Indeed, implant treatment complications negatively affect the whole dental implant industry. Indeed, it is not difficult to grasp that fewer complications lead to happier patients and more acceptance of implant-based treatment. Diagrams of an RMS show features that would be considered unique to the dental industry and result from 10 years of research by Emil L.A. Svoboda, Ph.D., DDS, to make the installation of implant prosthetics safer for patients.

Search words: *implant treatment complications, fixed prosthetics, implant crown, subgingival cement, misfit joints, dental implants, risk factors for peri-implant disease*

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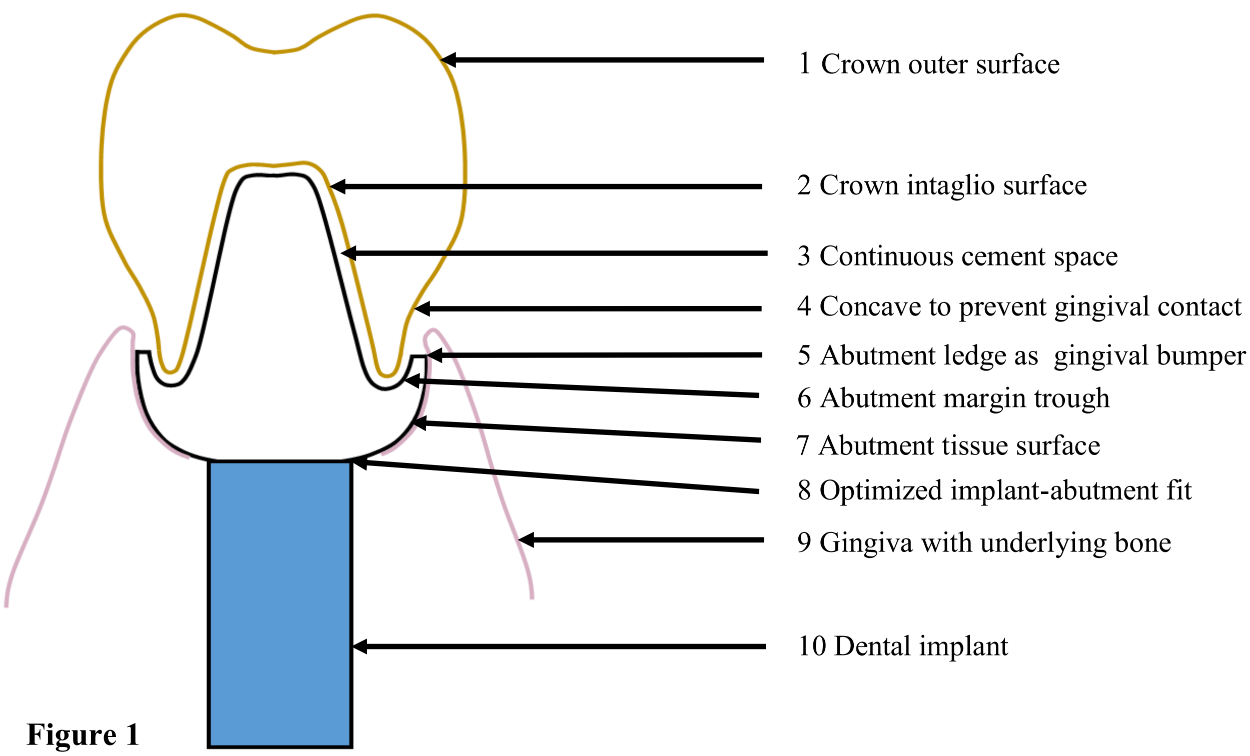

Figure 1

Figure 1 illustrates the contours of the RMS design to show how the abutment and crown interact with each other, their retaining implant and their adjacent tissues. This system allows the dentist to install a prosthesis optimally while safely tolerating expected PDE, ICPOI and the TE while exerting optimal control of the extrusion and cleanup of excess cement during the intra-oral cementation process. Figures 2-4 will show how this system mitigates the risk factors for peri-implant disease. The prosthesis installation process begins with the optimized installation of the abutment onto the dental implant, followed by the safe intra-oral cementation of the prosthesis. This entire process can be well-controlled by the dentist to give consistently optimized results for the patient. Simplicity is the mother of consistency.

Discussion of design features depicted in Figure 1

1) Crown outer surface & 4) Concave to prevent gingival contact:

While the crown's outer surface profile is conventional above the tissues, its shape is unique in the area adjacent to and under the tissues as it does not interact with them during crown installation. Its shape adjacent to tissues varies from straight to concave until the surface profile exceeds the height of the gingiva by about 0.5 mm. This design feature prevents the negative consequences of RTDE and the GE and ensures the free flow of excess cement away from the abutment-crown interface towards the occlusal surface of the crown. This design prevents submarginal cement flow and makes it easier for the dentist to remove excess cement. It also helps the dentist adjust contacts without traumatizing adjacent soft tissues that can swell and bleed to make intra-oral cementation more challenging. When pontics are involved, it is easier for the dentist to adjust the tissue surface of the pontic as there is no need to manage tissue displacement adjacent to retainers simultaneously.

2) Crown intaglio surface & 3) Continuous cement space

The cement space is crucial for managing PDE and ICPOI of oral structures, implants and prosthetic components. It is continuous around the entire interface between the crown and its retainer. It allows for three-dimensional movement of the prosthesis within the confines of the RMS abutment-margin trough. **The cement space is adjusted to 80 microns to manage common errors for a single crown**. **For a 3-unit bridge, this space can be safely increased to 120 microns** to manage the larger error expected due to the increased prosthesis size.

Space is a risk factor for peri-implant disease. This cement space is different from the space created by manufacturers to manage PDE and ICPOI to facilitate the installation of the prosthesis by the screw-in system. The cement-in system uses cement to fill that space to prevent the inoculation and incubation of oral pathogens and their subsequent invasion of peri-implant tissues. Space under or on oral tissues related to the screw-in system of prosthesis installation often fills with oral pathogens that are difficult for the patient immune system to mitigate.

5) Abutment ledge as gingival bumper & 6) Abutment margin trough

The abutment ledge is the horizontal portion of the abutment finish line and can vary from 150 to 300 microns in width. It acts as a gingival bumper that prevents the gingival from interacting with the prosthesis shape in the peri-abutment area. The tissue-facing edge of the gingival bumper will be slightly rounded to avoid tissue trauma. Varying thickness allows the clinician to control the displacement required to allow the free flow of excess cement away from the adjacent tissues and provide the dentist with a tactile clue that makes it easier to remove excess cement.

The abutment trough allows the crown margin to float within its confines. This feature makes the adjustment of contacts with adjacent teeth easier, as the prosthesis will not interact with adjacent gingiva during the adjustment process and will be somewhat self-centering. This feature also makes it possible to compensate for PDE and ICPOI and to mitigate the TE to prevent open and overhanging margins and submarginal cement. These are all risk factors for peri-implant disease.

This diagram shows the margin about 1 mm below the gingival margin. When stretched by the abutment, the free gingival margin tips towards the prosthesis and may block the free flow of excess cement. The dentist should see the gingival bumper before cementation when the crown is seated.

7) Abutment tissue surface

The shape of the abutment tissue surface can vary according to the desired emergence profile and the space existing between the top of the implant and the tissue surface. Its shape should apply some pressure against the gingiva to provide a relative barrier against penetration by excess cement. The RMS provides adequate space for excess cement to move out of the tissue space when a low-pressure cementation of 20 NCm or less is used for seating the prosthesis.

Unlike the Chamfer Margin System (CMS), which causes open margins at such low installation pressures, the RMS does not because of its enlarged cement space and adequate sluiceway for excess cement between the gingiva and the prosthesis. At standard 40 NCM pressure installations with CMS prosthetics, even equigingival and slightly supra-gingival margins can result in cement injection into the tissue spaces.[4]

8) Optimized implant-abutment fit

The cement-in system of prosthesis installation provides the dentist with the best chances for optimizing the implant-abutment fit. The clinician can install each abutment individually, and each abutment is free to realign itself with the optimal path of insertion determined by the implant screw channel and its abutment connector. The dentist only needs to manage the RTDE at the time of its installation, as there is no attached prosthesis to obscure their view nor contacts with adjacent teeth structures to affect the alignment of the implant-abutment connection. Thus, there is also no PDE or prosthesis-related ICPOI to manage. These will be handled at the time of the installation of the prosthesis as described above.

The screw-in prosthesis installation technique involves one or more abutment connectors embedded in the prosthesis. Thus the dentist must try to manage the TE, PDE and ICPOI simultaneously. This feat is difficult to impossible to manage adequately under the best conditions. Implant and abutment connectors are made to tolerances of ±5 μ, and the prosthesis is made to tolerances of ± 50 to 150 μ. One can see that embedding the abutment connectors within a much less accurate prosthesis would misalign the abutment connectors beyond the tolerances managed by the implant connectors. In addition, it would be *challenging for the dentist to adjust contacts at ±5 μ to manage ICPOI. In short,* ***the screw-in system of prosthesis installation is fatally flawed*** *and should not be used without discussing such flaws and their dire consequences with patients. Implant-abutment and abutment-prosthesis misfits are preventable risk factors for peri-implant disease.*

9) Gingival and underlying bone

The gingiva may be considered soft tissue. However, it varies in its **Resistance to Displacement** during abutment and prosthesis installation, as it depends on its thickness, distance from bone or tooth structure and the density of its tether to bone tissue. Soft tissue representation in current design software is often primitive. It does not consider these tissue characteristics, so designers need to guess where the surface of the gingiva might be after the abutments are installed. For the RMS abutment designers, I believe the technicians are doing a great job if they can place the margin ±0.5 mm. While dental designers position abutment margins 0.5 mm subgingival, I expect that position to vary from 0 to 1 mm when I install them in the mouth.

If the esthetics are critical, use a Titanium base with a cemented zirconia abutment shape. Some implant companies have taller Titanium bases. These might be better when expecting higher occlusal loads. When the loads are highest, it will be prudent to use RMS custom titanium abutments.

Once the abutment is confirmed seated and double torqued into place, the prosthesis installation process is usually straightforward and controlled. Since the RMS abutment profile is wider than the prosthesis emergence profile, it can be more challenging to install. Indeed, a stock or custom healing abutment to widen the access to the top of the implant or minor surgery to release the gingival tether from bone can expedite the optimal seating of the RMS abutment. Any blood or tissue fluid exudate is usually easy to manage with this RMS abutment design.

10) Dental implant

Today there appears to be more frequent use of narrower and deeper implants. The literature seems to support narrow implants placed deeper in the bone as part of the platform-switch concept. From a mechanical point of view, narrower implants have thinner, weaker walls, and platform switch prosthetics have longer abutment-prosthesis lever arms that increase stress on implant-abutment connections during function. Add to these problems, while a single screw-in tooth has a significant likelihood of misfit connections, installed multiple-unit prosthetics come with guaranteed misfits. While length also magnifies error, are the misfits and related stresses on the prostheses and connections even worse than those expected from shorter implant-abutment complexes? I suspect patients whose treatment includes narrow implants with deep platform switch abutments retaining their prosthetics will succumb to more "flowered" and broken abutment parts over time. In a recent Academy of Osseointegration-sponsored DocMatter chat, Dr. Barnard Longbottom (Periodontist) revealed that he is detecting "a surprising number of fractured implants." I am not surprised.

Let's go back to deep implant placement and platform switch. One 2020 review[5] indicated some possible small benefits to using the Platform Switch concept. I question whether such a small benefit is clinically significant considering platform-switch implants' deeper placement. Some of the research reviewed used the top of the implants as a reference to measure bone loss over 5 years. Platform-matched implants lost 0.5 mm more bone than platform-switched implants placed 1-2 mm below the bone level. What we frequently see around deep implants is bone loss down to the top of the implant. So, is it beneficial to lose 1-2 mm of bone from the top of the alveolar ridge over a platform-switch implant rather than 0.5 mm bone from the top bone level implant over 5 years? I have no idea why this below-the-bone placement of implants has become so faddish. There was no difference in implant failure rate. Will the platform-switched implants fail more often over 10 years due to the flowering of the implant tops? We will see. The RMS is compatible with platform-switch implants. Perhaps preventing optimizing the fit of connections will extend their useful lives.

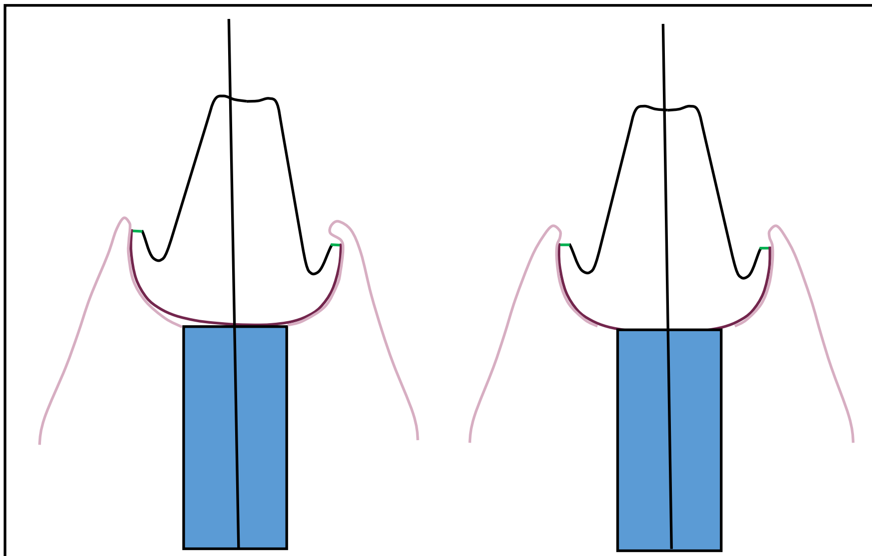

Figure 2 **Figure 3**

Figure 2 shows an abutment being installed with a path of insertion 3 degrees off the dental implant. **Figure 3:** The abutment is free to move and thus able to align itself with the path of insertion dictated by the fixated implant.

Discussion of Figures 2-4

Figure 2 shows an abutment being installed with a path of insertion **3 degrees off** its complimentary implant retainer. The implant is not free to move as it is fixated in the jaw-bone. However, the abutment is free to move and can thus adjust and center itself to **connect opti-**

mally with the implant, as shown in **Figure 3.**

The dentist will need to manage the adjacent gingival and underlying hard tissues as required, but without the crown attached, this process is easier to manage. Once installed, the abutment can no longer move without loosening the abutment screw. Indeed, this connection takes advantage of the ±5 µm tolerances of both the implant and abutment connectors. Achieving an optimized fit of these components is the dentist's goal and is consistent with the spirit of Health Canada and FDA testing.[6] It is clear that misfit joints would likely not pass Government tests for stability, and they put patients at an increased risk of mechanical failure and peri-implant disease.

Figure 4: The abutment-crown connection can compensate for PDE and ICPOI while preventing the Tissue Effects. Note that the crown and crown margins are tilted (3 degrees). One can imagine that an adjacent tooth contact has caused the crown to shift somewhat to the left during installation. However, the crown margins are still within the trough of the RMS abutment shape. There also appears to be a slightly different path of insertion for the crown than the implant and abutment. The RMS has managed this ICPOI, while a non-soluble and high compressive strength resin-cement fills the space between the abutment and prosthesis. The cement eliminates space for oral pathogens. There are also no tissue-facing open or overhanging margins with excess cement extensions that are difficult to keep clean. Finishing lines that face the occlusal are much easier to access and maintain by patients and dental care professionals.

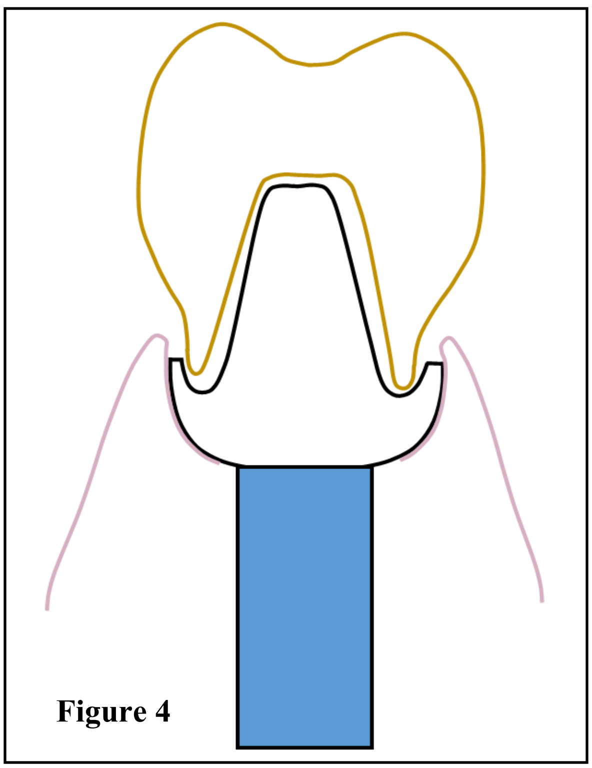

Figure 4: The implant-abutment connection is optimized. The crown's path of insertion is not the same as that of the implant and abutment. It is rotated 3 degrees due to tight contacts caused by PDE or ICPOI. The cement space tolerates the crown's malposition within the confines of the RMS abutment trough without causing open and overhanging margins, and subgingival cement.

What about excess cement being injected into the adjacent tissues? The abutment margin trough redirects the excess cement away from the tissues, and the abutment gingival bumper and prosthesis concavity **(Figure 1&4)** provide space that facilitates the movement of that excess cement away from the tissues.

The RMS is unlike the Chamfer Margin System. Along with the enlarged cement space (80 µ) and floating crown margins, the dentist can easily seat the crown with low-pressure cementation (20 NCm or less) without fear of open margins and subgingival cement.[4,7] The abutment gingival bumper also makes the excess cement, especially in the rubbery state, easy to locate and remove effectively with minimal trauma to the adjacent gingiva. These RMS design also prevents the adjacent tissues from touching and resisting the seating of the prosthesis during its installation.

Now you know how the RMS manages the root causes of complications related to prosthesis installation and why the safe use of cement space is key to this process. Applying this knowledge can make prosthesis installation better for patients and dentists. It is not a fight of screw-versus cement; it is using our knowledge and understanding to do the best possible job for our patients.

Let's dig a little deeper and realize another truth. Any parts designed to touch, like the implant-abutment connection or the chamfer margin to finish line connection, have little or no tolerance for error. Touching parts can only bind or slide along each other's surfaces.

A lateral force that displaces an abutment more than ± 5 µ will stress the abutment and implant connector to the point that something needs to give. Will the implant connector be distorted or flowered? Will the abutment screw be bent and weakened or broken? Will the abutment be distorted or sit at an odd angle? In any case, misfit parts are not ideal for the patient.

What about the chamfer margin? Suppose the crown is pushed laterally by a tight contact or other adjacent tissues. In that case, the prosthesis margin either binds and causes the crown to tilt or slides up the inclined plane of the abutment finish line and retainer. So we will have an open margin and an overhanging margin. Is that what we want?

In addition, we need to consider residual subgingival cement related to these margin misfits and the Gingival Effects (GE). Add on the consideration of tissue fluids that, when put under pressure, can displace cement between connecting parts and create voids under a prosthesis ripe for microbial invasion. It's all bad for the patient.

The RMS is different. *It provides the dentist with a means for assembling the prosthetic tree optimally in the mouth, from the implant to the prosthesis, with simple steps that are easy to perform safely without exposing patients to longstanding risk factors for complications.*

The two primary purposes for cement are to retain the prosthesis and to fill the space. The space between misfit joints differs from the cement space, as the latter is filled with cement to reduce or obliterate that space. Also, resin-based cement is not soluble and has high compressive strength, even at a thickness of 300 microns. Cement thus holds the prosthesis tight and does not allow the micropump movement commonly attributed to misfit joints.

There are other advantages to the RMS. The cement space can be safely increased to 120 microns and more to mitigate the root causes of complications for longer-span bridges. When installing a bridge, the pontics may need some adjustment. This process is much easier when the pontics are the only prosthesis part that contacts the gingiva. The RMS bridge is self-centering because of the cement space distribution around the prosthesis–abutment interface. The contacts are thus easier to adjust.

What about the desire to make a prosthesis easily retrievable?[8] Cement-in systems can be made as retrievable as screw-in systems. A caution, the retrievability feature has a high cost, the least of which is the nuisance of replacing and repairing screw-access holes. **Indeed easy retrievability is created by sloppy fitting implant parts that build a hidden tolerance to the root causes of mechanical complications.** This desire for easy prosthesis retrievability appears to have been met covertly by implant manufacturers at the expense of patient health. Yes, 81% of implant patients can expect to experience implant loss and/or peri-implant disease. This poor expectation is indeed troubling. I want manufacturers to provide dentists with fit tolerances because creating space in the tissue environment is a recipe for disaster.

All prosthetics are removable. Some prostheses need to be sectioned for easier removal. Prosthetics do not usually need to be removed to tighten or replace retaining screws. Very few screws will need to be tightened or changed when the connections are optimized during installation. It only takes a few minutes to drill through a crown to gain access to a retention screw for tightening or replacement services.

Perhaps it is time to move from a stock-parts-based all-on-X prosthesis installation system to a custom-abutment-based system with segmented prosthetics. These do not require massive tissue removal and reduce the consequence of implant complications. Consider the RMS a breath of fresh air in a stagnant room. What do you think?

Conclusion

The Reverse Margin System is unique in enabling the dentist to prevent several longstanding risk factors for treatment complications inherent to other current installation systems.

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Author

Emil L.A. Svoboda PhD, DDS has lectured and authored many articles on safer prosthesis installation to reduce the troubling prevalence of treatment complications. He has identified the root causes of the mechanical problems that are well-known risk factors for mechanical and biological complications like peri-implant diseases and their dire consequences for dentists and their patients.

Indeed he has coined several new dental words and concepts to help dentists better understand how and why current installation systems prevent the dentist from achieving better results. Perhaps it is time for educators, manufacturers and government oversight bodies to learn about Prosthesis Dimensional Error, Incongruent Paths of Insertion and the Tissue Effects so that they can better support dentists' efforts to make dental treatment safer. The Reverse Margin System prevents several risk factors for peri-implant disease. The author developed it to mitigate the risk factors for treatment complications.

Go to www.ReverseMargin.com to learn how to make your treatment better for your patients.