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Implants in your Laboratory: Abutment Design

By Leon Hermanides, CDT

A patient's anatomical limitations have the greatest predictive value for successful esthetic integration of the anterior implant restoration. What this means to the dental technician is that for some of our anterior implant cases, despite our best efforts and highest levels of technical competence, they will never look fantastic.

Understanding these limitations has enormous value in the laboratory as the financial impact of remaking these cases and potentially losing a customer can make laboratories reluctant to manufacture anterior implant restorations.

Figure 1:
Due to the implant position being mesial to the ideal position these abutments (custom abutments fabricated by Atlantis Components) are designed flat on the mesial profile but still posed restorative contouring challenges.

Cemented vs. Screw-Retained Restorations

So, why use an abutment? There appears to be a significant demand to manufacture screw-retained restorations rather than an abutment and cemented crown. The most obvious reason is correction of an implant angle would leave the screw access hole as an esthetic liability. This is most common with maxillary anterior teeth where the bony architecture tends to create a facial inclination of the implant to avoid apical perforation of the buccal plate. The implant, therefore, is inclined toward the facial and leaves the screw access hole either through the incisal edge or in the facial of the restoration.

It has been noted in several articles on porcelain-fused-to-metal crowns that the screw-access hole in the screw-retained restoration leads to lower fracture resistance of the ceramic. Implant restorations are at a higher risk of mechanical failure therefore with screw-retained restoration the risk of ceramic failure is increased.

Additionally, it appears that the choice of an abutment/cemented retained restoration or a screw-retained restoration has no significant impact on the survival of the implant itself. Although these articles dispute those findings, all the authors would agree that accessibility to the

restoration margins to clean the excess cement is vital when an abutment is necessary.

Processing Distortion

Another important issue when choosing between cemented or screw-retained restorations would be the fit of an implant supported by fixed partial denture. In multiple studies, the data has shown that when evaluating frameworks fitted to implant fixtures manufactured by a variety of methods, there is measurable distortion. By cementing the frameworks, the inaccuracies created by casting and bonding ceramic were minimized and stresses transferred to the implants by regular processing distortions were mitigated by providing adequate cement spacer. It has been demonstrated that the cement spacer does not compromise the retention of a cemented restoration and in fact improves the fit of the seated restoration.

Adequate Inter-Occlusal Clearance

One of the challenges in manufacturing an implant abutment is creating adequate retention and resistance form to prevent the restoration from dislodging. When assessing the vertical space between the implant fixture surface and the opposing dentition less than 5mm would not provide sufficient space for the abutment margin (.5-1mm), adequate resistance form (3.5mm), or the appropriate thickness of restorative material (1mm). In these situations, the screw-retained restoration would be a better option as the hardware required to manufacture the restoration would allow adequate thicknesses of the ceramic materials.

Retained Cement

The chief concern voiced by many restorative dentists against the use of a cemented crown and abutment is the amount and accessibility of retained cement after final delivery of the restoration. However, this can be controlled by the use of a soft tissue model to accurately reproduce the soft tissue profile around an implant and placing the crown margin no more than 1.5mm below the gingival margin. In fact, for a titanium or metal abutment margin depths of 0.5mm on the lingual, 1mm on the mesial and distal and 1.5mm on the facial should provide adequate access to the margins for the restorative dentist to clean the cement and hide the junction between abutment and restoration.

☛ QUICK TAKE

In this article, Leon Hermaides, CDT, discusses the biologic and mechanical principles that are developed as criteria for abutment design to help create better predictability with implant esthetics.

Figure 2:
Implant restorations on the maxillary laterals and right first bicuspid, supporting cement retained PFM fixed partial denture on No. 7 to No. 10 a single PFM on No. 6 and cement retained PFM on No. 5. (Photo courtesy Dr. L Cirtaut)

The Soft Tissue Model

In order to provide access to the implant replica during the manufacturing process, a soft tissue model is required for implant restorations. This allows a clear view of the interface between abutment and replica to ensure the components are fully seated and verify the fit of the restorations, which is critical when manufacturing fixed partial dentures. Additionally, this allows the technician to sculpt the ideal emergence profile between the implant fixture and the gingival margin into the silicone material, which can then be replicated during the manufacturing of the abutment.

Material Selection

For anterior tooth replacement, material selection is an important factor in esthetic success depending on the amount of tooth and gum displayed in the smile. It has been shown that depending on the thickness of tissue over the abutment, a titanium abutment may shadow through the soft tissues. When the tissue thickness was less than 2mm the human eye would detect the light reflection from the titanium abutment.

It is critical for the technician to recognize that any implant placed facially to the adjacent teeth or less than 3mm below the expected final

Figure 3: *(Below)*
A screw retained implant fixed partial denture showing ideal implant placement for lingual screw access.

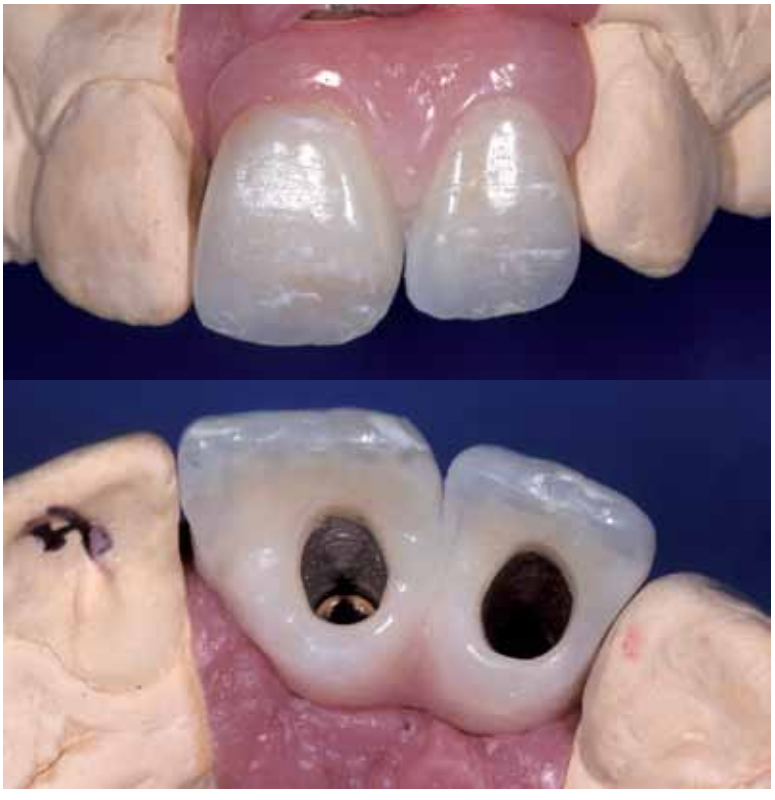

Figure 4: *(Below)*
Using a soft tissue model and a periodontal probe it is possible to very accurately locate an abutment margin depth.

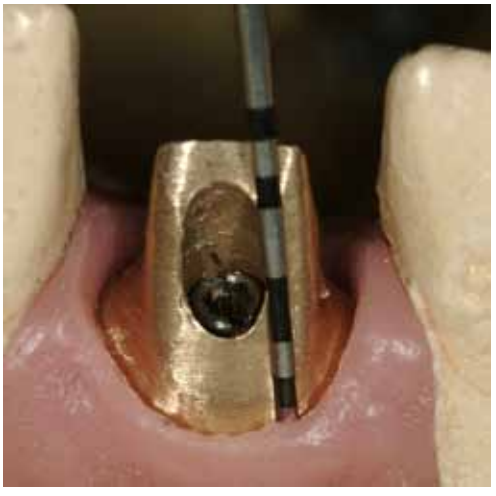

Figure 5: *(Below)*
The soft tissue material on a model allows the sub gingival contours of the abutment to be adapted to ideal contour and when removed provides access to the analog interface.

gingival margin on a patient showing the cervical of the teeth in their smile may require a zirconia abutment. This will minimize the shadowing apical to the gingival margin seen with titanium abutments. Patients who do not show the cervical of their teeth in a big smile give the laboratory more flexibility in material choice, and the risk of the reflection of the titanium showing is minimal.

Zirconia abutments are also an excellent option when the accessibility of the restoration margins is of concern, as it possible to leave the margins closer to the final gingival margin. If there is any future recession, the junction between tooth and restoration is less visible and there is less likelihood of the shadowing expected with a metal abutment.

Design Parameters

There are a set of parameters that can be used to determine the outcome of the final result. The abutment needs to fulfill the following criteria:

- Provide adequate retention and resistance form to retain the final crown and an appropriate path of insertion.
- Create the emergence contour to emulate the surrounding dentition.
- Keep the margins accessible for adequate cleaning of any retained cement.

Retention and resistance of and an abutment taper of 6° and a minimum prep length of 3-4mm are the ideal parameters. This will provide adequate retention and resistance form providing the screw-access hole does not compromise the facial or lingual wall of posterior abutments or the mesial or distal wall of anterior abutments. The use of proximal retention grooves on posterior teeth will enhance the resistance to dislodging.

The emergence profile of an implant abutment is the most important restorative determinate of the final facial gingival level, providing that the anatomical limitations discussed earlier in this series of articles are favorable. Placement of an implant in an unfavorable position in relation to the final tooth position poses the greatest challenge to the technician manufacturing the implant abutment.

Ideal placement of an anterior implant would be 3-5mm apical to the gingival margin of the contra lateral tooth. The facio-lingual inclination of the implant should be angled through the incisal

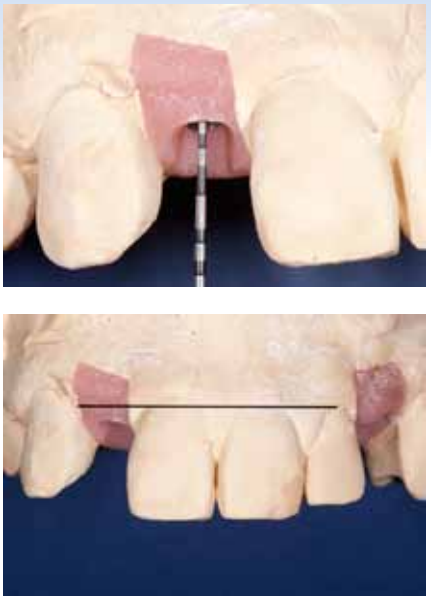

Figure 6:
This implant has been placed at a normal depth relative to the tissue level of the site, however as can be seen from the pictures it will be impossible to create a restoration the same length as the contra lateral tooth due to the coronal position of the implant.

Figure 7:
As this provisional restoration demonstrates the tooth length discrepancy is significant.

Abutment Design Recommendations

- Use a soft tissue model to replicate the contours of the gingiva between the implant interface and the gingival margin and provide adequate access to the implant interface.
- When restoring the anterior dentition and for high risk esthetic cases, use a custom abutment. Stock abutments are better for use on posterior teeth.
- Keep the facial contour of the abutment flat or concave to promote tissue volumes.
- Interproximal contours should allow for the appropriate placement of the proximal contact points on the restoration and promote tissue volume.
- The restoration margins should be accessible for adequate cleaning of the residual cement. Facial depths no more than 1.5mm, proximal depths of no more than 1mm, and a lingual depth of no more than .5mm are adequate.

edge, and with the mesiodistal inclination parallel to the roots of the other teeth. A faciolingual placement allowing 2mm of buccal bone will additionally prevent loss of the facial tissue. Creating an appropriate emergence profile when all of these factors are ideal is relatively straight forward, however the day-to-day reality for the dental technician is usually that the implant placement does not meet one or more of these criteria.

There are three critical dimensions to the emergence profile of the abutment, the combination of which will determine the final position of the gingival margin, the presence of interproximal papilla and the gingival profile of the restored tooth.

- Facial emergence
- Proximal emergence
- Lingual emergence

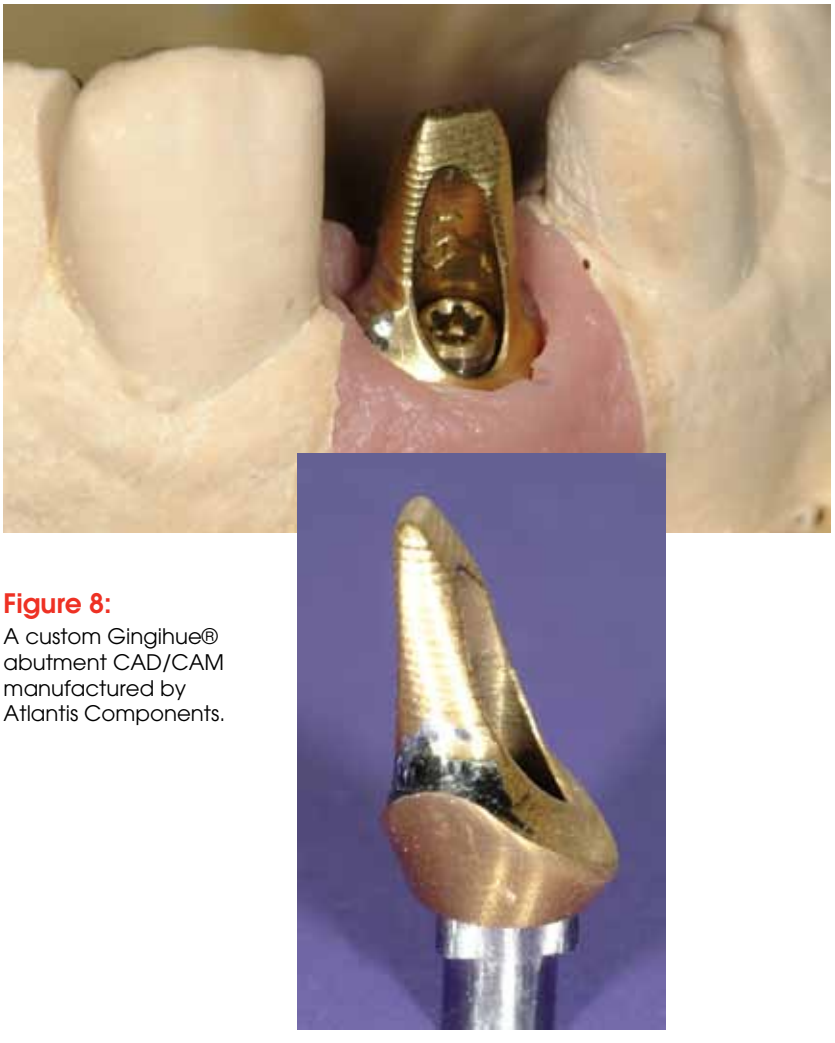

Figure 8:
A custom Gingihue® abutment CAD/CAM manufactured by Atlantis Components.

In facial emergence profile, it has been demonstrated that a concave profile can increase the volume of tissue around the abutment and conversely the convex profile of an abutment will create an apical migration of the soft tissue. Therefore, as the facial profile of the abutment is developed, it is crucial to determine the final gingival position of the restored tooth.

If the gingival margin of the restored tooth were apical to the contralateral tooth, (the restoration would create a longer tooth) the profile of the abutment would need to be flat to concave. This would allow the tissue to drape further down the restoration and shorten the visual length of the restoration. However, when the implant has been facially positioned, placed shallower than 3mm below the gingival margin, or placed with an excessive facial inclination the opportunity to correct the visual length of the restoration is compromised.

Conversely, when the gingival margin is coronal to the contralateral tooth (the restoration would create a shorter tooth) the profile of the abutment can be slightly convex in order to displace the soft tissue apically and correct the visual length of the restoration. This can be done by adjusting the gingival level and soft tissue profile on the soft tissue model and manufacturing the abutment to this modified profile. However, if the implant has not been positioned 3-5mm deep relative to the final gingival margin, modification may not be possible as demonstrated in Figure 6 and 7.

In proximal emergence profile, the proximal contours of the abutment influence the presence of interproximal tissue by providing adequate emergence for the appropriate crown contour and contact point placement. For the single tooth replacement implant, the bone level, and the presence of the interproximal papilla is determined by the adjacent teeth. In adjacent implants, the inter-implant distance appears to influence the height of interproximal bone and corresponding interproximal papilla.

It is not the abutment that supports the tissue, but rather the ability of the abutment and restoration to favorably conform to the anatomy and existing tissue volume which will create the gingival profile and interproximal papilla. The emergence profile of the abutment in the interproximal regions should therefore begin to approximate the contours of the natural tooth to provide a seamless transition to the restoration.

As for lingual emergence profile, the lingual profile has little impact on the peri-implant esthetics and can be adapted to form the expected contour of the root of a tooth.

Stock vs. Custom Abutments

As the parameters for emergence profiles and margin accessibility of an abutment are understood, it becomes more difficult to justify the use of stock abutments for anterior teeth. Stock abutments are abutments where the profiles of the abutments are developed to a perceived ideal by the implant company, and allow the technician to adapt the core to the required angulation, length and taper.

It is possible to differentiate between anterior and posterior teeth in your choice of abutment. As the esthetic requirements for a posterior restoration and the flatter scallop of the interproximal bone provide greater flexibility, the use of a stock abutment is more appropriate for posterior implant restorations.

The relative cost of currently available CAD/CAM options for custom abutments and the quality of the final restorative outcome, does however support a recommendation for the use of a custom abutment for implant restorations in the esthetic zone. **JDT**

About the Author:

Hermanides graduated from college in South Africa with a national higher diploma in dental technology, the equivalent of a bachelor's degree in the U.S. He has worked in South Africa, London and Seattle laboratories specializing in all stages of advanced reconstructions and anterior esthetics. Hermanides is a mentor of Dr John Kois' Kois Center programs and a member of study clubs around the Puget Sound area. He serves as president of the Washington State Dental Laboratory Association, vice chair of the Foundation for Dental Laboratory Technology and as an NADL board member.

Figure 9:
With the implant restoration on tooth No. 8, the interproximal bone on the mesial of No. 7 and No. 9 can be sounded to verify the appropriate contact point placement from the proximal crest of bone to ensure complete regeneration of the interproximal papilla. (Photo courtesy Dr. D. Jayne.)

Figure 10:
This image shows the difficulties of using a stock abutment to restore anterior teeth. As the abutment profile was insufficient the margins are lowered to allow more room to develop the emergence profile.

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