

SELECTED READINGS

IN

ORAL AND

MAXILLOFACIAL SURGERY

**TREATMENT OPTIONS FOR THE
EDENTULOUS ARCH:
A Logical Approach for the
Restorative Doctor and Surgeon**

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TREATMENT OPTIONS FOR THE EDENTULOUS ARCH: A LOGICAL APPROACH FOR THE RESTORATIVE DOCTOR AND THE SURGEON.

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INTRODUCTION

Utilizing dental implants for treatment of the edentulous arch has been the treatment of choice since the inception of endosseous implants from Dr. Brånemark. The first restoration, the metal-resin fixed detachable implant prosthesis (e.g. hybrid restoration), proved to be one of the most predictable solutions for the mandibular edentulous patient.(1,2) This restoration has recently become more popular among both restorative dentists and implant surgeons alike. Public awareness of complete arch reconstruction has dramatically increased due to various marketing approaches by doctors and implant companies. However, as with conventional implant dentistry, education with respect to this restoration is virtually non-existent in the pre-doctoral education setting. The education that is available to both the restorative and implant doctor is often geared towards the “how to” as opposed to the “why”. As the technology is becoming more advanced in treatment of the edentulous patient, the basics with respect to diagnosis and treatment planning remain the same. Appropriate diagnosis, prognosis, and treatment planning are critical to success. Communication with the restorative clinician, the implant surgeon and the laboratory are absolutely critical throughout the duration of treatment.

In dealing with the edentulous arch, or the arch that is indicated for edentulism due to a failing dentition, it is imperative that the oral and maxillofacial surgeon understands and is able to articulate the multiple treatment options. Often, the general dentist may not feel comfortable with full-arch implant-supported treatment plans. Additionally, full-arch cases can be bothersome for dentists because they often involve sacrificing teeth that have a guarded prognosis but have not yet failed. Unfortunately, much education in implant dentistry is market driven, and the restorative doctor may only present an option emphasized by a respective implant company. Moreover, the restorative doctor may not be aware of soft or hard tissue reconstruction options that could allow for a more predictable treatment. For the care of the patient and for medicolegal reasons, the patient must be presented a list of treatment options,

risks and complications, and expected outcomes for all available treatment options. All too frequently a patient presents with a failed dentition having undergone recent placement of multiple implants in a single quadrant with complete disrespect for the “big picture”. As an implant surgeon and more importantly as an oral and maxillofacial surgeon, it is imperative to not merely be a “placer” but be an active doctor in the implant process. Naturally, the only clear way to present a treatment option is to understand how it is performed, both from the surgical perspective as well as the restorative perspective. (Table 1)

BACKGROUND

The fact that corporate dentistry has created full arch reconstruction centers should be evidence enough to demonstrate

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| TABLE 1: KEY TREATMENT PLANNING CONSIDERATIONS IN FAILING DENTITIONS |
| What arch typically fails first? |
| What about the opposing arch? |
| Avoiding the restorative nightmare Edentulous mandible and a fixed or natural dentition maxillary arch |
| Lip support |
| Smile line |
| Space requirements |

that there is a need to provide for patients with failing arches. Because full-arch cases are often more complex surgical cases and may involve other medical comorbidities, the oral and maxillofacial surgeon must be the leader in providing surgical options.

Numerous factors are involved with the new emphasis towards hybrid restorations. The high success rate of dental implants lends itself to offering large restorations of considerable costs on fewer implants. Demographic trends dictate a dramatic increase in older patients seeking treatment, and in general the baby-boomer generation demands a higher quality of treatment options. AAOMS often references that 24.4% of adults by age 65 have lost all their permanent teeth(3). In addition, insurance companies are now covering a portion of dental implant care. Marketing, to include direct patient marketing from implant companies, has increased awareness of treatment options.

Lastly, we now have multiple treatment options for patients that provide a dramatic range of post-operative functionality to include immediate loading of the prosthesis. To simplify verbage, for the purpose of this article, the term edentulous arch includes

a failed or failing dentition that will become edentulous as part of the treatment plan. That is, for treatment plans involving implants, for the majority of cases immediate implants are placed in fresh extraction sockets and the treatment options are the same as a patient that presents as edentulous.

TREATMENT OPTIONS FOR THE EDENTULOUS ARCH

Treatment options for the edentulous arch can be simplified into removable or fixed options.(Fig. 1 on page 4) Removable options include a denture, an implant-supported over-denture, or a fixed-removable option that has a bar fabricated on the implants and a removable appliance attaches directly to the bar. For fixed options the patient will either have a hybrid restoration or multiple implants restored with traditional crown and bridge.

Removable Options for the Edentulous Patient: Dentures

For the oral and maxillofacial surgeon a treatment plan for an upper and/or lower denture generally is straight forward. Pre-prosthetic surgery may include extraction of remaining teeth, alveoplasty to remove undercuts, and tori removal. While oral and maxillofacial surgeons are comfortable with these procedures, as implant surgeons it is important to understand that these are functionally very poor alternatives.

For most patients the maxillary arch will fail before the mandibular arch. For this reason and the social stigma that exists for complete dentures, the maxillary arch may be the arch for which the patient will first seek treatment. The disadvantages of the

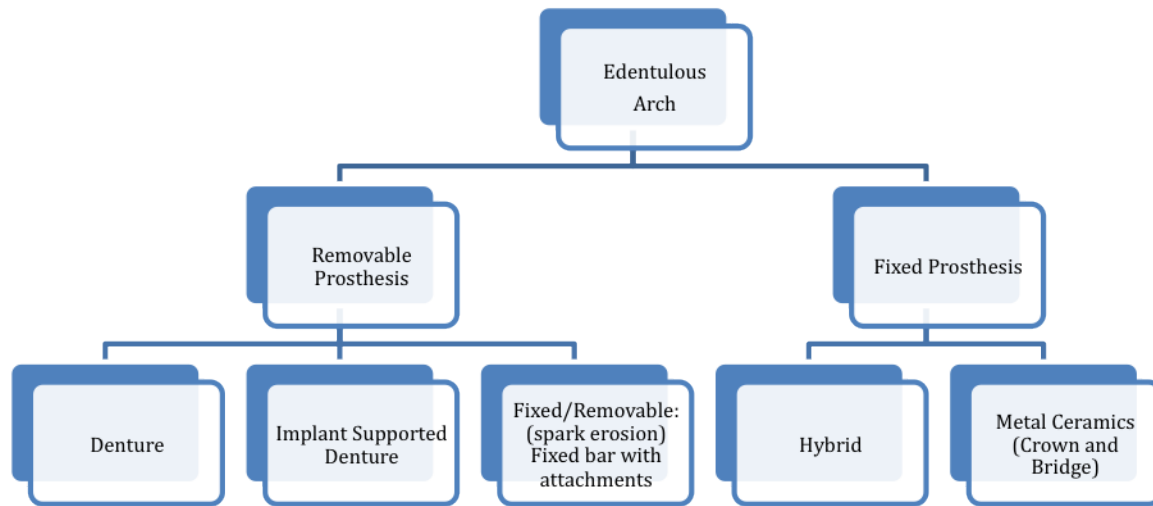


Figure. 1 Treatment options for the edentulous arch.

maxillary complete denture are well known: limited ability to incise, lack of or alteration of taste, coverage of the palate, the “denture look”, and the fact that it is a removable appliance. Additionally, patients that suffer from xerostomia have a very difficult time gaining retention of the prosthesis.

However, there are several advantages to a maxillary complete denture. An upper denture can be functional, and with some training will provide adequate masticatory support. With saliva, in most cases, significant retention can be gained. Moreover, the palate provides profound support and stability. In fact, due to palatal support and the lack of palatal bone resorption, statistically the maxilla will not become atrophic nearly as often as the mandible despite the poor bone quality in the maxilla. The esthetics of a maxillary denture can be as good as any

treatment in a well-made situation. Lastly, the fees for denture restorations are markedly less than any implant restorative options.

Because the maxillary denture can provide an acceptable option in terms of function, esthetics, and costs, one must be careful when considering the maxilla to not expend all the patient’s financial resources with implants only in the maxilla. As we will continue to emphasize, prior to initiating a maxillary implant restoration the mandibular arch must be considered first. In our practices, resources often need to be used in the mandible, and restoring to an upper denture is often the treatment of choice.

In dealing with the lower arch, it is universally accepted that the lower denture is difficult to tolerate for the patient and provides a very poor functional outcome. Due to

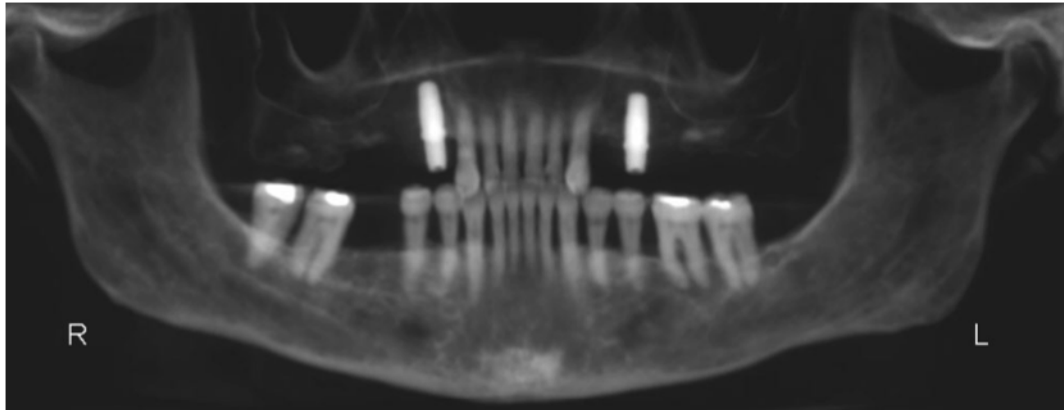


Figure 2. Pantograph of a patient with current upper implant-supported partial denture desiring additional maxillary implants to convert to fixed metal-ceramic restorations. Patient with >50% bone loss of all natural teeth, leaving existing dentition with very poor prognosis. Restoring the maxilla with a fixed option will certainly cause the mandible to fail in a very short period of time. Options for the mandible must be discussed with the patient prior to any treatment in the maxilla and ideally both arches should be treated simultaneously.

this, the lower arch should be the emphasis of implant reconstruction.

In some cases, only a single arch is indicated for treatment and the opposing arch can be maintained. As previously mentioned, often the maxilla fails first. Restoring a patient with a fixed or implant supported maxillary restoration opposing a mandibular denture is generally contraindicated due to the destruction that occurs to the mandible and the lack of function and comfort that ensues. (Fig. 2) Therefore, if the prognosis of the mandibular arch is guarded to poor, then elective implant therapy should be directed toward the mandible first.

Commonly a patient will press the issue to have the maxilla restored and wait for the mandible to fail. If implant therapy is treatment planned on the maxillary arch with a compromised mandibular arch, then the patient must be informed of the need for future treatment when the mandibular arch fails. It needs to be emphasized that a lower denture

against a fixed maxilla is contraindicated. Thus, the patient needs to understand options and the fees associated with future implant treatment on the mandible. It is a very sad state when all the patient's resources are spent on the upper arch first and the failing mandible has not been addressed.

Implant Treatment Options for the Edentulous Arch

The treatment options for an edentulous mandible include: 1) implant attachment overdenture; 2) a conventional hybrid: titanium substructure (bar) and acrylic/denture teeth and acrylic suprastructure (teeth); 3) both splinted and non-splinted implants—metal-ceramic fixed restoration; 4) full zirconia: zirconia substructure (bar) and zirconia suprastructure (teeth) fixed implant restoration; 5) titanium substructure (bar) with zirconia or porcelain superstructure (teeth) fixed hybrid restoration. Each of these restorations has different restorative and surgical consid-



Figure 3. Considerations to guide restorative options.

erations.

Each of the factors in Figure 3 must be fully understood by all parts of the team prior to embarking upon a comprehensive treatment. As such, when these are fully understood for each treatment option, the appropriate choices for each clinician and the patient become narrowed and streamlined.

Working under the assumption that the mandibular arch has a good prognosis or is being restored, the full spectrum of treatment options can be considered for the maxillary arch. (Fig. 4 on page 7) The maxillary treatment options include both removable and fixed restorative options. While patient preference is certainly considered, the clinical and radiographic exam will often dictate removable versus fixed in the maxilla. This will be discussed in detail in the following section. Future treatment options, opposing arch

consequences, costs and follow-up complications must also be considered.

For the mandible, implants are generally necessary to provide any functionality to the full arch prosthesis. While much literature supports the use of an implant overdenture approach for increased patient satisfaction,⁽⁴⁾ we feel that this is perhaps overstated with respect to functionality, long-term implant success, and restorative complications. The key to this treatment option is dependent on the ability to fabricate a stable lower denture that will provide lateral stability with flanges. The implants are only to assist in increasing retention, i.e., all the same factors that prohibit a functional lower denture are still present. This leads to soft tissue inflammation and loss of attached tissue around the implant abutment. Such implants have a higher failure rate. All too often the patient is referred for placement of two implants in

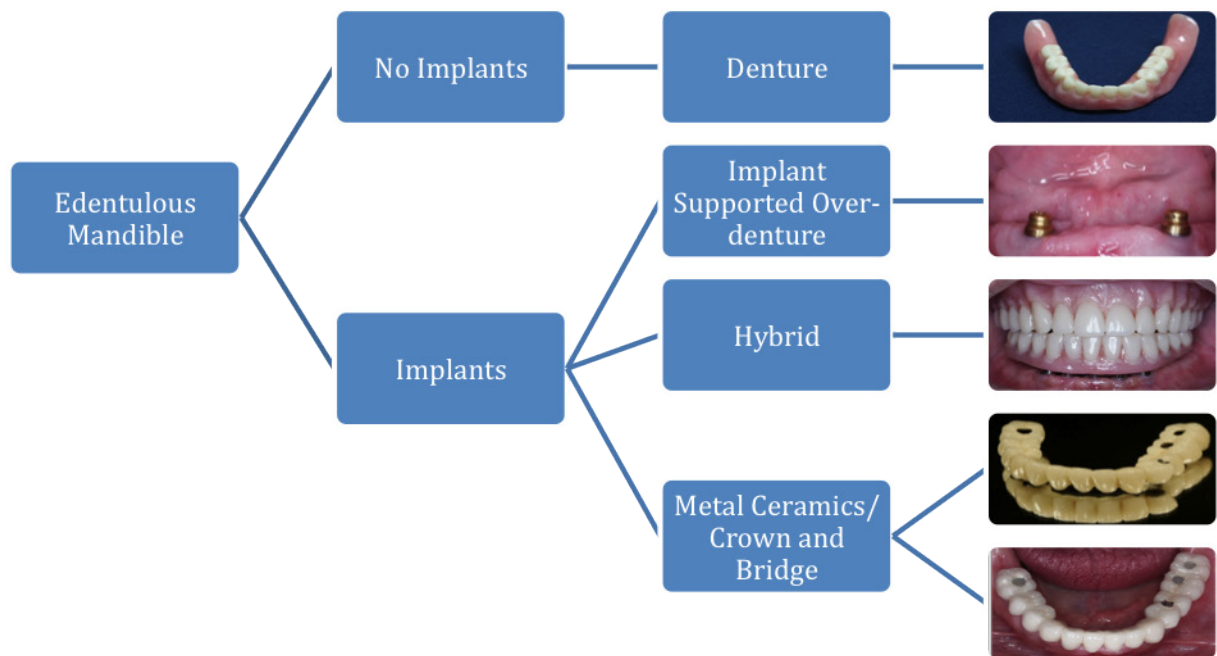


Figure 4. Treatment algorithm for the edentulous mandible.

the mandible to increase stability when the patient has no vestibule and the frenum attachment clearly displaces the denture. In such a case, two implants will only marginally improve the situation.

Two implant overdentures are best used in the situation in which a patient has tolerated a stable lower denture for years (often losing his/her teeth at a younger age) and the lower denture is now become increasingly mobile. This patient was able to accommodate to the lower denture when the alveolar ridge was ideal. In such circumstances, two implants restore the patient to the previous state of health and the outcome is a success. In general, it is our opinion that in cases in which two implants are placed the patient may eventually convert to a full hybrid prosthesis. Bone reduction and implant placement should allow for a later conversion, i.e., alveolar reduction is often still performed for an implant supported mandibular overdenture and the placement of the im-

plants should be in sites to allow for future hybrid transition.

For the mandible, the ideal treatment is the hybrid full-arch restoration. Studies demonstrate excellent long-term prognosis in both vertically and tilted placement of the implants.(5,6,7) In the mandible, a denture conversion is often performed so the patient does not have to endure negative quality-of-life issues and poor patient satisfaction from wearing a poor fitting lower denture.(8) The issues with lip support and visibility of the prosthetic gap are of minor concern in the lower arch. Appropriate surgical reduction of the alveolar bone (15 mm restorative space in the anterior) is critical to the success of the prosthesis and to decreasing maintenance. Additionally, placement of the implants with lingual emergence is key in the anterior region, although appropriate reduction of the alveolar bone generally dictates this will naturally occur. The main disadvantages of the lower hybrid are anterior tooth fracture,

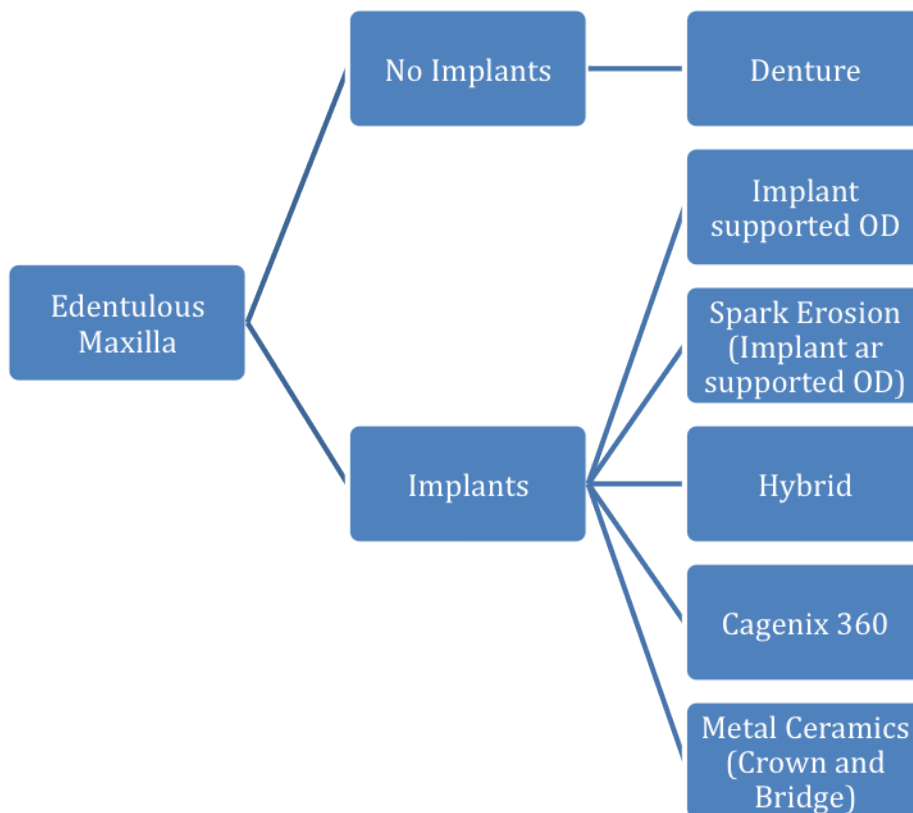


Figure 5. Treatment algorithm for the edentulous maxilla.

posterior tooth replacement and screw complications.(9)

DECISIONS FOR THE MAXILLA

Treatment options and decisions for the maxilla are markedly more complex than for the mandible. (Fig. 5) Clinical findings during the physical examination as well as radiographic findings may preclude a certain treatment option or make an alternative treatment a more viable option. Block described an approach to evaluating the maxillary arch. (10) In some circumstances, this may differ with what the patient desires for treatment. It is imperative that both the restorative doctor and the oral and maxillofacial surgeon be able to communicate with the patient in the

same language as to why certain options are recommended.

Decision Algorithm for the Maxillary Arch

First, does the patient require lip support from a flange? If this is the case, then the patient needs to be informed, and the ideal treatment is a removable appliance. This may be a denture or an implant supported prosthesis.

Where is the smile line? Will the patient have gingival display and if so can the restorative seam be hidden? If the restorative seam is not visible then a fixed restoration is appropriate. If the restorative seam is visible

leading to poor esthetics, a fixed option may not be appropriate. If the restorative seam is visible but is at the junction of the patient's restorative teeth and gingiva, then typically a fixed restoration will be aesthetically acceptable.

As previously discussed, in the maxilla a full denture can be a viable option.(Fig. 5) The palate will often provide support and the alveolar bone resorption will stabilize at a level for which a functional, retentive upper denture can be made that will serve most patients for many years. We emphasize this point because financial resources are often limited for reconstruction of the arches. It behooves a clinician to emphasize a fixed option in the lower arch and an upper denture; i.e., put the resources where it will benefit the most.

The majority of patients seen in our offices undergo a treatment plan of an upper denture opposing a lower hybrid. This treatment is considered the minimum treatment to restore a patient to a truly functioning dentition. For patients that have accepted the lower hybrid treatment, then a discussion is had concerning improving the upper arch from the full denture.

Additionally, patients present in which the upper arch is failing and the lower arch has a good prognosis. Often these patients have previously had implants placed in the posterior of the lower arch, i.e., they have been restored with conventional implant supported crown and bridge. Due to loss of bone, poor bone quality in the maxilla, or the large numbers of implants needed, a full arch implant supported restoration may be the most predictable treatment option.

In the maxilla, the first step in the algorithm is to decide on a fixed versus removable restorative treatment. Much like maxillary orthognathic surgery, the key issue is the upper lip and tooth-show at rest and animation. Additionally, bone volume in the alveolus needs to be sufficient for lip support. If a patient presents with an existing dentition, then logically replacing the natural dentition with acrylic or ceramics will be acceptable in terms of lip support. The only issue pertains to the prosthetic margin of the restoration. Can it be hidden under the lip to be esthetically acceptable? Will the final prosthesis provide for a hygienic restoration?

If the patient has severe vertical bone loss (the primary indication for full-arch reconstruction) or is wearing a prosthesis with an anterior flange, then likely an acrylic flange will be needed to maintain upper lip support.(Fig. 6) This is not to say that lip support cannot be gained from an upper hybrid restoration, (Fig. 7 on page 10) but prosthetically it is much more difficult. In these cases, generally the prosthetic seam is superior and not visible with full animation.

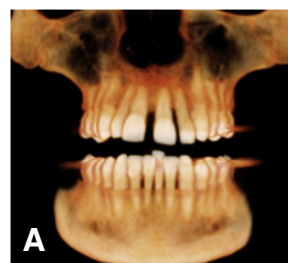


Figure 6. **A.** Severe vertical bone loss, **B.** Atrophic upper lip restored with acrylic flange to provide for soft tissue support (splinted implant bar and clip overdenture)





Figure 7. Maxillary hybrid with no visible prosthetic margin.

The most difficult cases in the maxilla involve patients with significant gingival show during animation. Several treatment options can be considered. A denture prosthesis with a full flange will extend the prosthetic margin above the upper lip. Fixed crown-and-bridge type of prostheses, as done with single implant restorations, allow for an esthetic emergence of the prosthetic from the gingiva, but this option is still prone to the many difficulties with anterior tooth replacement and soft tissue contours and blunting papilla. Another option is for surgical reduction of the residual alveolar ridge to move the restorative margin more apical so that the margin is hidden under the upper lip. Lastly, and certainly more complex, the patient can undergo alveolar repositioning (maxillary segmental or LeFort impaction) to appropriately place the maxilla to a more suitable position.

Space Requirements in the Maxilla

For an upper denture, vertical space is only an issue if severe super-eruption has occurred. Patients with an anterior restorative space of less than 15 mm will typically be restored with a fixed prosthesis. This is because the restorative space is not adequate to restore with a metal-resin fixed prosthesis or a metal-resin overdenture prosthesis without surgical alteration of the osseous space.

Patients with 15 mm to 17 mm of restorative space in the anterior can be restored with a fixed metal-resin prosthesis. (see P. 12) Patients with 17 mm to 20 mm of anterior restorative space can be restored with a bar overdenture prosthesis. (see P. 11) If the patient does not present with such spacing, the surgeon will need to perform osseous reduction respective to the individual treatment option performed.

CONSIDERATIONS OF EACH PROSTHESIS AND SURGICAL REQUIREMENTS FOR THE MAXILLA.

Implant Supported Overdenture

While a maxillary denture may be an acceptable option, some patients who require a flange for upper lip support will not want an upper denture due to the issues mentioned above. There are three main advantages of an implant-supported overdenture: 1) Uncovering the palate which improves taste and proprioception for the tongue, 2) the ability to incise, and 3) a more secure prosthesis.

Two options are available to the restorative doctor for an implant supported overdenture: 1) free-standing overdenture abutments, i.e. LOCATOR® abutments and 2) splinted implant bar and clip overdenture. Both options involve placing four to six implants in the maxilla which differ surgically only in their space requirements.

Free-standing Overdenture Abutments

Once the maxillary implants are integrated, attachments can be placed on all of the implants or as few as two of the implants. However, the more attachments that are placed the more complex the path of inser-

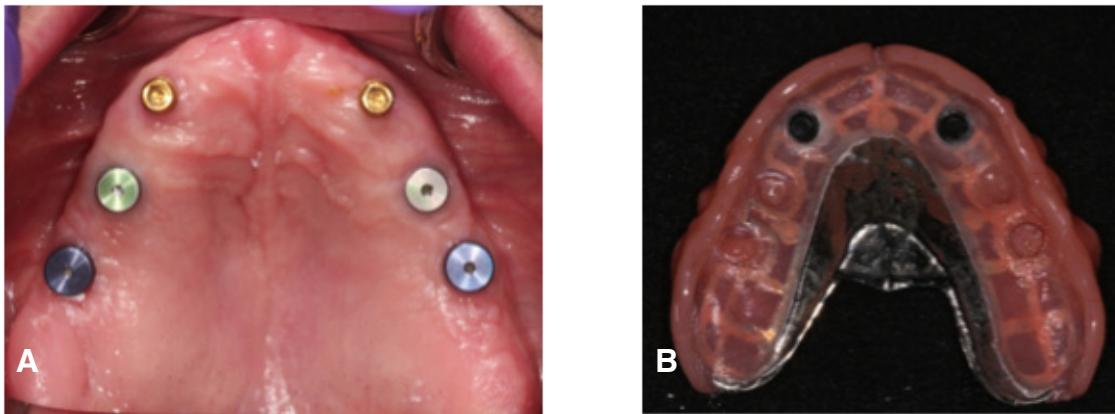


Figure 8. A. Free standing overdenture abutments, B. horseshoe palatal coverage.

tion becomes. As divergence increases, restorative maintenance increases and overall fit decreases. The advantages with this treatment include horseshoe palatal coverage, familiarity from the restorative perspective with using LOCATOR® abutments, and cost savings from the restorative perspective. (Fig. 8) The main disadvantage with LOCATOR® abutments in the maxilla is that the implants are not rigidly splinted. Takahashi, et al. demonstrated an option to “splint” the implants using a cast framework embedded in the denture that fits over the copings, in essence providing rigid stabilization and splinting.(11) However, even with this technique the implants are not truly splinted.

Utilizing LOCATOR®, the denture is tissue borne and lends itself to complications associated with residual ridge resorption, leading to a poorer fitting prosthesis over time. The resulting increased stress on the implants in the maxillary bone commonly leads to peri-implant mucositis, peri-implantitis and ultimately implant failure.

Minimum implant/osseous level space requirements for the LOCATOR® abutment in the posterior maxilla are: 2 mm for soft tissue collar, 3 mm for LOCATOR® abutment

height, 2 mm for acrylic resin and 5 mm for posterior denture tooth height; a total of 12 mm of restorative space.

Several surgical considerations for placing implants in the maxilla for LOCATOR® abutments need to be addressed. Maxillary bone has poor density and due to resorptive patterns the implants, notably in the pre-molar area, become slightly angled to engage the palatal bone. This will lead to slight facial inclination of the LOCATOR® abutment. If the denture is poorly made and has mobility, the attached mucosa will be at risk. Moreover, parallelism of implant placement is an issue as a “path of draw” is needed to seat the Locators. Additionally, due to the preference of having anteroposterior spread and posterior retention, bilateral sinus augmentation is often necessary to place the posterior maxillary implants.

Splinted Implant Bar and Clip Overdenture

The second option is often considered a “fixed-removable” option. (Fig. 9 on page 12) Four to six implants are placed in the maxilla. A bar is then fabricated with restorative at-

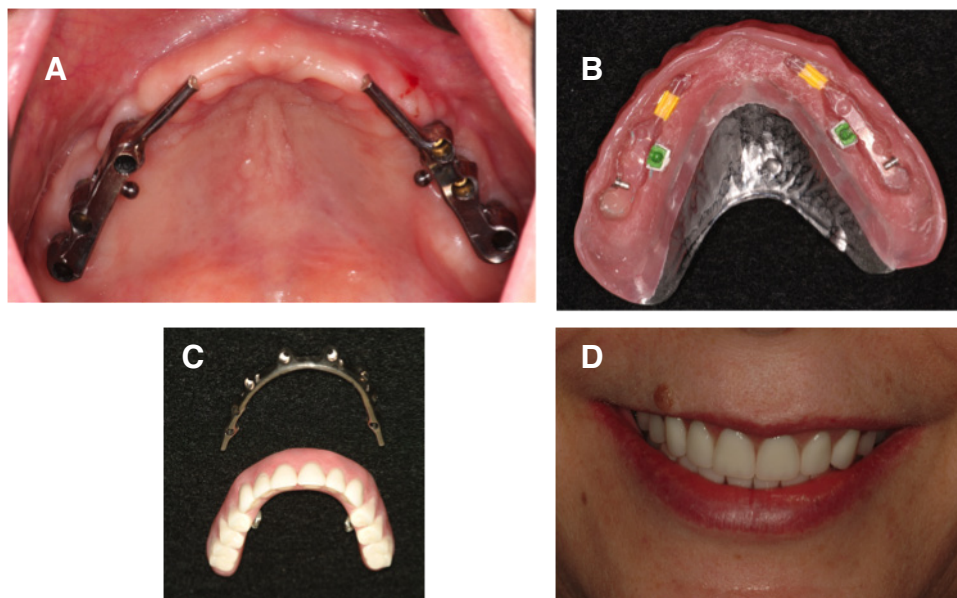


Figure 9. Two examples of splinted implant bar with overdenture attachments. **A.** demonstrates a split bar; **B.** demonstrates overdenture clips and a reinforced horseshoe palate; **C.** demonstrates a solid bar and the prosthesis; **D.** is the prosthesis worn by the patient.

tachments designed into the prosthesis. The major advantage of this prosthesis is that the maxillary implants are splinted, statistically improving their long-term success rates. Additionally, the denture, being removable, provides a ridge lap flange so the disadvantages of hygiene and speech issues seen with the hybrid restoration are eliminated. Also, the prosthesis is no longer tissue borne and generally the attached mucosa is more predictably maintained. The disadvantages of this prosthesis are: 1) increased overall cost, 2) technically more difficult restorative procedures, 3) significantly more prosthetic maintenance than any other restorative prosthesis, and 4) has the “stigma” of a removable appliance.

Hybrid Prosthesis

It has become increasingly popular to restore the maxillary edentulous patient with

a fixed-detachable metal-resin hybrid prosthesis. Several key factors must be considered and discussed to ensure an ideal outcome: 1) restorative space requirements, 2) location and placement of implants, 3) surgical planning to assist prosthetic maintenance, 4) speech, comfort and lip support issues, 5) number of implants, 6) high lip line, 7) maintenance of the appliance, and 8) restorative sequence. Many issues concerning the maxillary hybrid are related to the final restoration and its maintenance.

The re-popularization of the original implant prosthesis has been brought to the forefront on the philosophy of four angled implants for the full arch prosthesis. This philosophy has merits and is certainly supported in the literature,(1,2,4,11) but also has become popular because of lower costs from using the minimum number of implants and parts. Such a prosthesis requires the utmost

in preparation and clinical execution. We also need to be careful to not be in a race to the bottom.

Full-arch implant prostheses have an excellent long-term track record with perhaps more literature demonstrating its success than any other procedure in all of dentistry. Unfortunately implants do fail, and with only a minimal number of implants present, failure is catastrophic. With “extra” implants (e.g., placing implants in #3 and #14 region with sinus lifts and more traditional vertical placement of implants) in the rare event of an implant failure, the entire restoration does not have to be remade. It does not become a major event for all parties involved.

It is a difficult argument to make that a six-implant-supported maxillary hybrid is not superior to one supported by four. Unfortunately, fees associated with additional implants, certain sinus bone grafting requirements, and other bone grafting that may be necessary begins to make the treatment so expensive that only a few can afford it. In contrast, during the planning phase fees are not included in the decision making process.

The idea of “global” or “universal” fees for the full-arch implant prosthesis has been very successful. With this philosophy, the number of implants is based on what is considered most ideal for that patient whether it be four, six or eight implants. Lecturers often talk of the “search for bone” in the maxilla in order to “get in” four implants. We would argue that while the implants may be integrated, the surgeon often fails to understand how this approach can affect future restorative maintenance. Attention to detail in the planning and placement of the implants can aid in decreasing future restorative issues. Sometimes this requires further reconstruction beyond implants to include hard and soft

tissue grafting in order to allow for more ideal implant placement.

Restorative space

For the maxillary hybrid restoration, the restorative space requires 15 mm minimum in the anterior region and 12 mm to 13 mm in the posterior; the height requirement for a posterior tooth is less than that of an anterior tooth. For example, based on an 11 mm implant, 26 mm of space is required for an anterior tooth from the planned incisive edge to the floor of the nose,⁽¹²⁾ making significant surgical reduction necessary to obtain the restorative space necessary to place the restoration. In the posterior maxilla, bone reduction may also be necessary in addition to maxillary sinus augmentation. This required reduction of the maxilla significantly decreases arch circumference and reduces the space for the dental implants. Moreover, reduction in the maxilla often removes the high quality cortical bone and leaves tabled bone that is of poorer quality. This in turn may decrease initial torque of the implants and may preclude the placement of an immediate fixed appliance. The patient should be made aware that they may be required to wear an upper denture during the healing phase.

Location and placement

The location of the implants should be well spread to adequately distribute the forces on the prosthesis. We prefer to place six to eight implants as a standard if the space is available in the maxilla. We also consider an angled protocol to avoid sinus augmentation, notably in patients that present with a history of sinus symptoms or mucous retention persisting in the sinus after medical management. This also assumes

that the emergence of the most distal implant approximates either the first molar or the second premolar. The goal is to minimize cantilever lengths and maintain excellent esthetics and phonetics.

In general, the placement should include placement of the implants as far distal as possible for posterior support such that there is not more than one posterior tooth cantilever. In the anterior there is debate over the exact location. Some prefer not to place any implants anterior to the canine area.(12) We prefer to place the implant in the central incisor region or lateral incisor region bilaterally, wherever the best bone is available. This provides excellent support for the prosthesis in the anterior and avoids a large anterior cantilever arc. These implants often have high initial insertion torque, leading to a more predictable plan for immediate loading. Additionally, the bone maintenance in the anterior is then secured so that no residual alveolar ridge resorption occurs and so a space does not develop long-term under the anterior section.

Surgical planning to assist prosthetic maintenance

A surgical guide should be provided to place the implants lingual to the anterior incisal edges and lingual to the posterior buccal cusps. If this cannot be attained then an angled abutment should be planned to re-angle prosthetic screw access so that all of the screw holes will emerge in a favorable location.

For the maxillary hybrid, if the implant sites are not well planned, prosthetic holes will exit through the facial cusps on the occlusal of the prosthesis. This outcome can lead to a common complication of posterior den-

ture tooth splitting, leading to difficult repairs. The most common complication of a hybrid restoration is prosthetic tooth fracture—a real and common complication that is frustrating to the patient and the restorative doctor. Again, placement of the implants in the appropriate position and the use of angled abutments can greatly reduce this risk.

Therefore, the implant placement and subsequent abutment choice should be done in such a way to avoid the prosthetic teeth facial cusps for integrity of the material and simpler maintenance in the future. Tolstunov described an anatomically based approach with set distances of “13-23-30”.(13) We would argue that this may suffice for some patients, but varying arch length mandates an individualized approach and this is not recommended. With cone-beam CT scanning and surgical guides from the duped denture, such a complex treatment merits more careful individualized planning. Often the more ideal placement is in the future embrasure spaces towards the palatal aspect of the prosthesis to avoid having holes in the acrylic teeth and to decrease the risk of the facial aspect from fracturing. (Fig. 10)



Figure 10. Ideal screw access sites for maxillary hybrid.

Patients need to understand that hybrid restorations require maintenance. Resin denture teeth will need to be resurfaced every 7-9 years due to wear. It is important that the patient is informed of this maintenance.

Lip support, speech, and comfort issues

If the patient needs to gain lip support from a flange then a removable overdenture should be considered. In order for the hybrid to be cleansable, a minimal gap is necessary. Even with an ideal gap, cleansibility of the maxillary hybrid prosthesis is difficult.

The maxillary hybrid prosthesis is in the zone of speech. Because the maxillary hybrid prosthesis is prone to air escape during speech, complaints about the bulk and difficulty enunciating speech with the prosthesis are common when compared to a metal ceramic prosthesis. The patient needs to be fully aware of this issue. If the clinician deems this will not be acceptable, then a removable appliance with a ridge-lap flange is the treatment of choice.

Number of implants

Four to eight implants have been recommended for the maxillary hybrid prosthesis. While the literature supports the use of four implants, for various reasons we prefer 6 to 8 implants. First, we recommend a “block fee” per arch in which the patient does not have to make the financial decision of placing additional implants. Second, with only four implants, a single failure may be catastrophic. If failure occurs prior to an integration check, significant additional treatment time will be required to allow for the replacement implant to integrate. If an implant fails in the final restoration, it will typically result in replacement of the entire prosthesis. This would be

a considerable expense for the patient or the doctor.

With “insurance implants”, a single implant failure most likely will have no effect on the treatment plan. Overall, we recommend the number of implants that best fits a particular patient to have the best long-term prognosis with the least amount of surgical and prosthetic maintenance. We do not recommend including the fee in the decision making process for number of implants with a high-end prosthesis. There are other ways to decrease fees for the patient, particularly with respect to the material choices for the restorative doctor, which results in more frequent but less catastrophic maintenance.

High lip line

The finish line of the prosthesis must end above the high lip line so as not to be visible on any functional movement.

Maintenance

The primary maintenance concerns for any metal-resin fixed-detachable hybrid prosthesis is fracture and wear of the prosthetic teeth. Technological advances have minimized the problems of screw loosening and screw fracture. Bar fracture should be virtually non-existent with adequate bar thickness and by controlling the cantilever lengths. We recommend two professional prophylactic cleanings a year with the restorative dentist, and removal of the prosthesis at least once a year.

Restorative sequence

The restorative sequence once implants are integrated is similar to a complete denture sequence and this is a major reason

why this treatment is so appealing for a restorative dentist. The typical sequence is: 1) Primary impression, 2) Final abutment level impression, 3) Occlusal registration record with record base and wax rim and verification jig, 4) Wax try-in, 5) Another try-in after bar fabrication is desired, and 6) Placement of the final prosthesis.

Future considerations

If the patient has a mandibular arch with a guarded or poor prognosis, it is the responsibility of the restorative and surgical doctor to inform the patient of the likely scenario that mandibular teeth failure will be expedited by the maxillary fixed implant prosthesis. Moreover, when the mandibular arch does fail the required treatment will be a fixed implant restoration; removable tissue supported prosthetics are contraindicated in patients with a fixed maxillary implant or natural dentition. The predicted future fees for reconstruction of the lower arch should be discussed before maxillary restoration.

Advantages of a maxillary hybrid

The main advantage of a maxillary hybrid is its being fixed. It provides splinting to the maxillary implants and provides for cross arch stability. It provides an esthetic and extremely functional dentition. (Fig. 11) Despite the previously listed issues with a maxillary hybrid, patient satisfaction is tremendous. (14,15)

Fixed Metal-ceramic Prosthetics

The restorative scenario for a fixed metal-ceramic prosthesis refers to a conventional crown and bridge philosophy in restoration. There have been many technological



Figure 11. Patient restored with maxillary and mandibular hybrid.

changes in this area in the past 2-3 years and they are become increasingly difficult to follow and decipher.

There are many advantages of the fixed-metal ceramic prosthesis: 1) minimal surgical reduction, 2) increased bone available for implant placement, 3) simplified implant placement, 4) better bone available for implant placement, 5) maximal preservation of keratinized tissue, 6) minimal speech concerns, 7) improved cleansibility, 8) comfort more similar to natural dentition, 9) excellent esthetics. However, the disadvantages include: 1) fracture of veneering porcelain is difficult to impossible to repair, 2) much more expensive, 3) the restorative sequence and procedures are very difficult. Due to these three disadvantages, this restoration has typically been avoided.

Key factors that must be considered to ensure an ideal outcome: 1) restorative space, 2) location and placement of implants, 3) surgical planning to assist prosthetic maintenance and number of implants, 4) speech, comfort and lip support issues, 6) high lip line, and 7) maintenance of the appliance all need to be discussed.

Restorative space

For maxillary metal-ceramic prostheses the space requirement is the same as that for conventional crown and bridge. The main difference is that in a full arch restoration, it is very challenging to shape the tissue of the residual ridge so that the prosthesis does not require any “pink porcelain” and still maintain esthetic teeth shapes. Therefore we recommend locating the high lip line and then allowing for 5 mm more of reduction to be able to have pink porcelain on the prosthesis. Five millimeters allows for 2 mm of prosthetic pink tissue and 3 mm of soft tissue running-room to the platform of the bone. You must identify the high lip line accurately so that you do not show the finish line of the prosthesis. Additionally, planning for gingival prosthetic architecture in the prosthesis allows the restorative doctor and laboratory technician to create ideal tooth shapes and contours.

Location and placement

The location of the implants is identical to the maxillary hybrid on page 13.

Surgical planning to assist prosthetic maintenance

Prosthetic maintenance is a major issue with implant-retained metal-ceramic restorations because the main complication is fracture of the veneering porcelain which can be difficult to impossible to repair. For this reason, this restoration has been avoided. However there have been significant technological changes that now allow us to re-visit this treatment philosophy because of the advantages mentioned above.

Lip support, speech & comfort issues

If this prosthesis is considered then the patient does not require a flange for lip support. This is typically not a problem for speech so long as implants are placed in the anterior for both short and long-term reasons. This is typically the most comfortable prosthesis for patients.

Number of implants

The philosophy for choosing the number of implants is the same as for the hybrid prosthesis on page 15.

High lip line

The finish line of the prosthesis must end above the high lip line so as not to be visible on any functional movement.

Maintenance

Long-term success with Ti frameworks is well supported in the literature.(16, 17,18) The primary maintenance concerns for any metal-resin fixed-detachable hybrid prosthesis is fracture and wear of the prosthetic teeth. Screw loosening and screw fracture have been minimized. Bar fracture should be virtually non-existent with adequate bar thickness and controlling the cantilever lengths.

Future considerations

As previously described, if the patient has a mandibular arch with a guarded or poor prognosis, it is the responsibility of the

restorative and surgical doctor to inform the patient of the likely scenario that mandibular teeth failure will be expedited by the maxillary fixed implant prosthesis.

Technology choices for metal-ceramic

Due to recent changes in technology there are several methods to restore this scenario: metal-ceramic, gold alloy with feldspathic porcelain over the metal, Cr-Co milled substructure with feldspathic porcelain over the metal, zirconia substructure with feldspathic porcelain on the facial surface only, titanium substructure with either E-max® crowns or zirconia crowns over the substructure.

Gold alloy with feldspathic porcelain over the metal

This typically is not an option anymore due to the high fracture rate of the feldspathic porcelain. Additionally the restorative sequence is very challenging if there are only 6 implants. If there are 8 implants then the prosthesis can be restored in three separate fixed bridges and the restorative sequence is a bit similar to conventional crown and bridge. Additionally the laboratory fee associated with this prosthesis is high.

Cr-Co milled substructure with feldspathic porcelain over the metal

This prosthesis is the same as with gold alloy, however, the cost is slightly less than a gold alloy substructure. The feldspathic fracture aspect makes it an undesirable choice.

Zirconia substructure with feldspathic porcelain in the facial surface only

This has been a newer advent for the industry and was born primarily out of cases that were originally planned as metal-resin hybrid restorations, but not enough reduction was performed. The substructure is monolithic zirconia and then pink gingival porcelain can be baked to it as well as facial feldspathic porcelain for improved esthetics. Because zirconia cannot be sectioned and soldered and an arc of zirconia cannot be made passive, a titanium cylinder is retrofitted and cemented in the zirconia to allow it to fit passively. The zirconia substructure is fabricated and overlying porcelain is baked to complete the prosthesis. Then the arch is assembled on an articulator with the cylinders retrofitted and cemented into the screw holes that are approximated at the implant sites. The sequence of this prosthesis is very challenging but the cost is less than for metal-ceramic restorations. However, fracture of the veneer continues to be a concern and the fit of the zirconia substructures does not have a proven track record, having been known to fracture. This prosthesis is as challenging as metal-ceramic because the porcelain cannot be repaired and the substructure cannot be repaired if it fractures, which zirconia has been known to do.

Titanium substructure with either E-max® crowns or zirconia crowns over the substructure

We consider this to be the restoration of choice. The CAD/CAM titanium substructure has the best overall track history as a substructure, even slightly better than the

gold alloy of the hybrid frame.(16,17,18) It is also inexpensive and easier to produce. The prosthetic teeth can be made of E-max® or zirconia with or without facial porcelain, allowing for premium esthetics. The pink prosthetic material can be made from either acrylic resin or porcelain and is the choice of the restorative dentist. Additionally, the restoration can also be executed with interocclusal distances of as little as 6 mm.

These restorations can be fabricated so that in the event of a prosthetic tooth fracture, it can be re-milled and easily replaced. Depending on the material choice, the entire prosthetic tooth portion can be replaced for a nominal fee. Typically, the companies that are offering this technology also place a lifetime warranty on the milled titanium substructure.

Not only is the maintenance aspect of this prosthesis the most appealing because of flexibility and low cost, but the restorative dentist's sequence is identical to that of the metal-resin sequence, which is by far the easiest restorative sequence for any full arch prosthesis. The overall cost is comparable to the metal-resin hybrid prosthesis, i.e., far less than more conventional metal-ceramic prostheses. It also has an easier restorative sequence, excellent esthetics and minimal yet simpler maintenance. We feel this is the future for full-arch implant restorative dentistry. There are several companies that make this technology available, however Cagenix® is the company with which we are most familiar and have the longest track record.

CONCLUSION

Restoring edentulous patients with complete arch implant prosthetics has a long and proven successful history. These are also

the most gratifying treatments for patients. However, there are many options and considerations for these treatment situations. The following conclusions can be made:

Avoid treatment planning implant prosthetics in the maxillary arch when the opposing mandibular arch has a guarded to poor prognosis. Guide the implant treatment therapy toward the mandibular arch first.

Treatment therapies for the maxillary arch include: Maxillary complete denture with either:

1) A four- to eight-implant fixed prosthesis, ideally a prosthesis with materials that fulfill most if not all of our outcome ideals. We recommend a titanium substructure with either E-max® or layered zirconia as the prosthetic tooth with pink architecture for the gingival. An example is the Cagenix® 360 prosthesis. The high lip line must be located and treatment planned around it.

2) A four- to eight-implant splinted bar and attachment overdenture. This is the treatment of choice if the patient requires a facial flange for lip support that can only come from a denture.

Treatment therapies for free-standing LOCATOR® maxillary overdenture should generally be avoided.

Treatment therapies for the mandibular arch can include one of the following: A complete denture, a LOCATOR® 2-4 implant overdenture, a 4-6 implant metal-resin fixed detachable hybrid prosthesis, or a 4-6 implant Cagenix® 360 prosthesis.

Dr. Michael J. Doherty earned his bachelor's degree from Gonzaga University and his dental degree from the University of North Carolina. After dental school, he completed a general practice residency at the National Naval Medical Center in Bethesda, MD. Dr. Doherty gained experience as a general dentist while serving in the U.S. Navy prior to entering OMS residency.

Dr. Doherty completed his oral and maxillofacial surgery training at the National Capital Consortium (National Naval Medical Center/Walter Reed Army Medical Center) in Washington, DC. During training, Dr. Doherty was Chief OMS Resident at the D.C. military hospitals that provided definitive care to many injured sailors, soldiers, and marines. Injuries of such severity are rarely seen in civilian hospitals. Dr. Doherty continually applies knowledge gained from this experience into all aspects of his surgical practice and feels honored to have provided care to such deserving individuals.

Prior to leaving military service, Dr. Doherty practiced at Naval Health Clinic Hawaii and was an attending surgeon at the Tripler Army Medical Center OMS Residency program. He trained multiple residents with an emphasis in facial cosmetic surgery, orthognathic surgery, maxillofacial trauma, and dental implantology.

In 2009 Dr. Doherty opened Rogue Valley OMS with an emphasis on the patient experience, maximizing technology to improve outcomes, and providing education to the dental and medical providers in his community. RVOMS has introduced multiple innovative techniques and philosophies in an effort to improve quality of care as well as to provide a decrease in fees to allow for more patients to seek optimal care.

Dr. Doherty is active in a variety of professional associations and societies and has authored articles and textbook chapters on maxillofacial trauma and dental implants. Dr. Doherty is a recognized lecturer at the national level in both trauma surgery and dental implantology.

Dr. Bradley A. Purcell received his dental degree with honors from Marquette University School of Dentistry in Milwaukee, Wisconsin. He received his specialty in prosthodontics and Masters of Science degree from The Ohio State University School of Dentistry. Dr. Purcell is a member of several professional organizations including the Academy of Osseointegration and the American College of Prosthodontists. He lectures nationally, continues to publish articles in the area of dental implants, and has been Assistant Professor at The Ohio State University School of Dentistry. Dr. Purcell currently maintains a private practice limited to prosthodontics at Spectrum Dental & Prosthodontics in Worthington, Ohio.

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