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Full-Arch Restorations on CAD/CAM-Milled Titanium Bars

Successful case results using verified two-stage impression and screw-retained LC resin basebar techniques.

By Thomas Wade, CDT

In the exciting, relatively new and rapidly growing arena of screw-retained hybrid and attached overdentures on CAM-milled titanium bars, there are two procedures/techniques that are critical to obtaining consistent predictable and successful results. results.

First are the impressions and model work necessary to achieve the final verified master cast. The master cast will be laser-scanned to produce an accurate CAM-milled titanium bar that will passively seat and interface with all of the implants (or abutments) in the arch. The "weak link" in this process is not the CAD/CAM technology but rather the human element. The onus is squarely on the clinician and laboratory technologist to produce the most accurate, verified master cast scientifically possible. When that is achieved, the quality of the restoration with regard to fit (passivity), strength, weight, esthetics, and function will be unsurpassed, state-of-the-art restorative work.

The second key aspect of the fabrication process is properly constructed screw-retained basebars. These are nothing more than the implant version of the acrylic or light-cured resin baseplates that have been used in the fabrication of conventional dentures and partials for many years. The difference is that they are screw-retained on temporary cylinders in order to eliminate the unnecessary (and unwanted) palate and border extensions of conventional denture baseplates. They also provide for highly desirable "diagnostics" during the early stages of fabrication, especially on restorations for the maxilla where consideration of additional criteria exist, such as lip support, high lip (junction) line, tight air seal for phonetics, and patient hygiene in difficult areas. Because most patients will desire a fixed (detachable) screw-retained device over a removable attached overdenture, the basebars will also provide an early indication as to whether the screw shaft access holes will present an esthetic problem as well as allow checking for any other divergence, vertical height, or concave ridge lap (sanitary) issues.

Even with conventional dentures, the importance and diagnostic capabilities of well-made baseplates have oftentimes been overlooked. The baseplate is reduced to "just a layer of acrylic on the cast to support some wax for the bite and try-in." However, if extensions and thicknesses are adjusted at the bite relation and try-in phase, the final prosthesis will already

Fig 1. The preliminary impression in a stock plastic tray with holes for open tray impression copings cut out by the clinician.

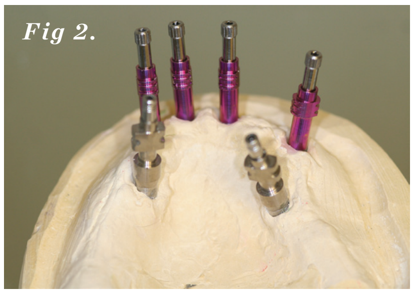

Fig 2. The technician retracts the impression copings from the preliminary impression and reseats on the cast.

Fig 3. The impression copings are splinted together with a rigid preformed bar stock and Pi-Ku-Plast.

Fig 4.

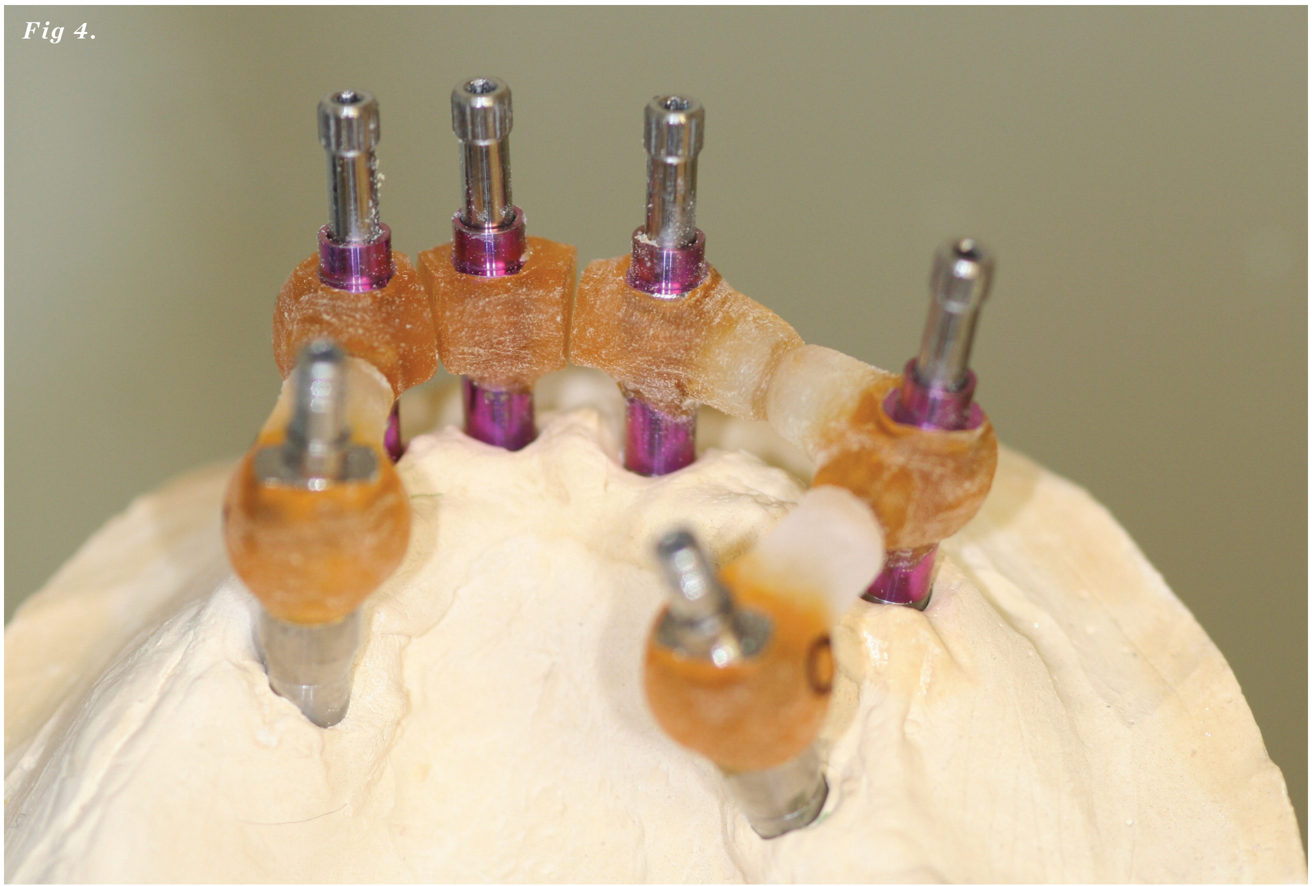

Fig 4. The intraoral luting jig for the verified impression, finished and sectioned.

Fig 5. Jig sections are sequentially numbered for the clinician.

Fig 6. A luting jig constructed with GC pattern resin.

Fig 7. A luting jig constructed with pre-formed bar stock and GC pattern resin.

Fig 8. A luting jig constructed with pre-formed bar stock and Pi-Ku-Plast.

Fig 5.

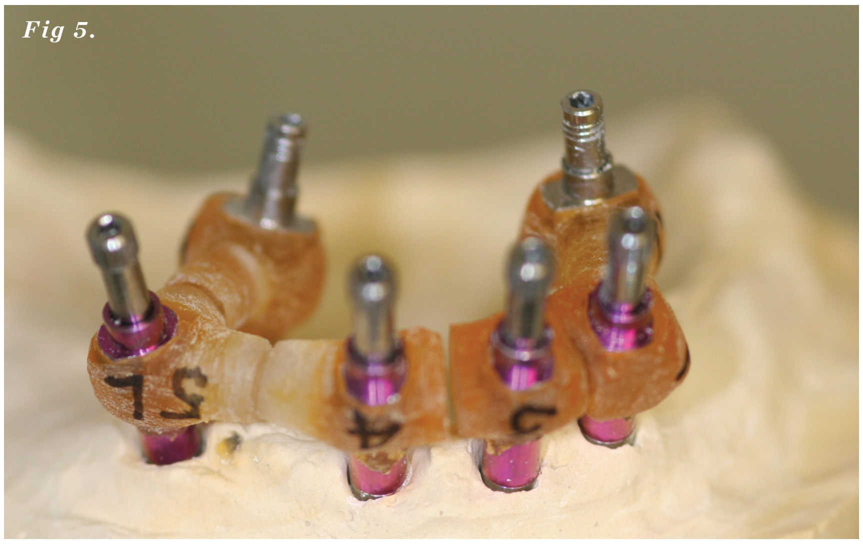

Fig 6.

Fig 7.

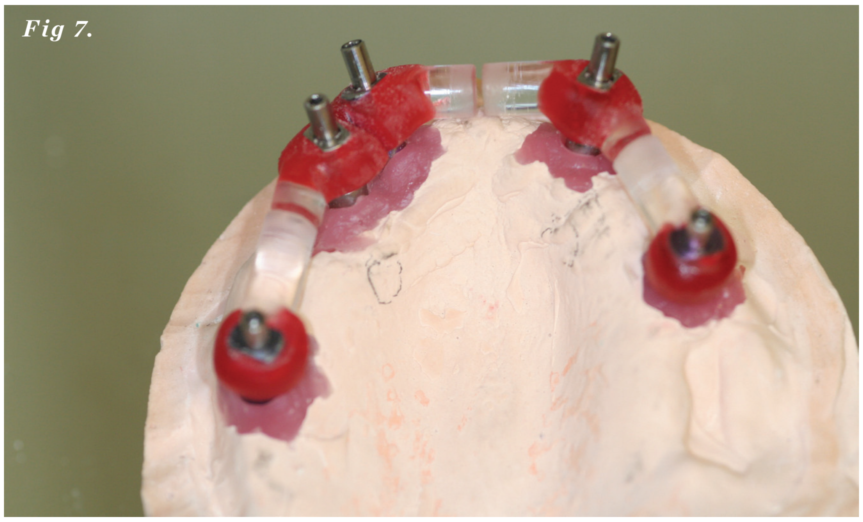

Fig 8.

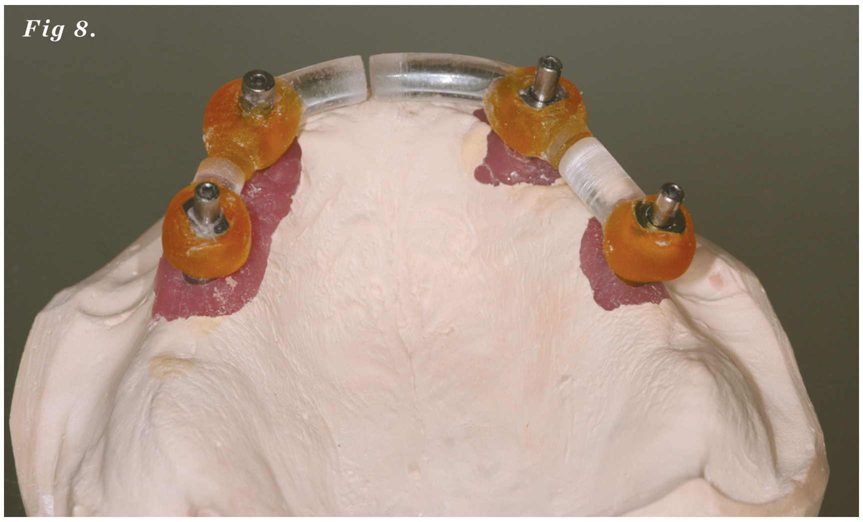

Fig 9.

Fig 10.

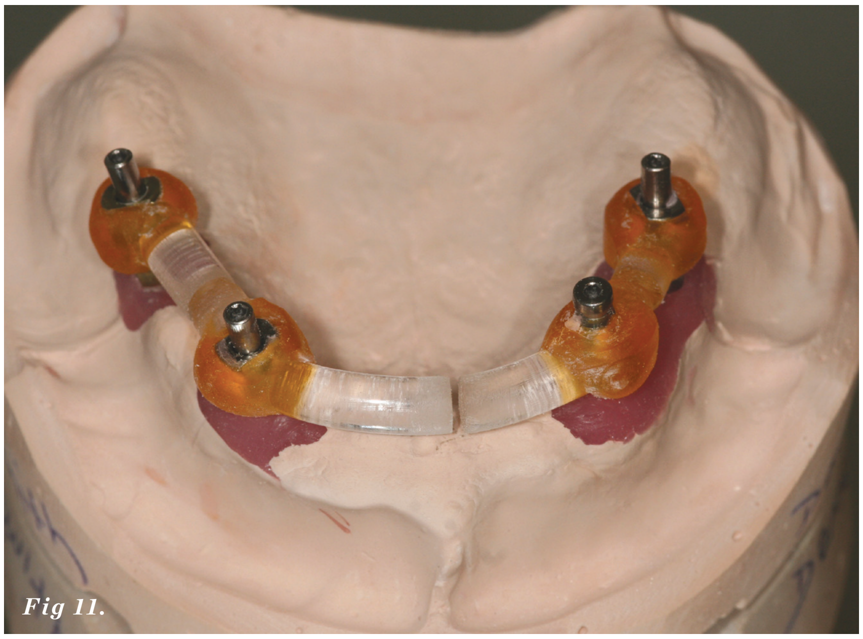

Fig 11.

Fig 12.

Fig 9. through Fig 12. The three luting jigs with corresponding precision custom trays.

Fig 13. and Fig 14. Highly divergent implants/impression copings with the corresponding custom tray. Note the slightly larger access holes to compensate for divergence.

Fig 13.

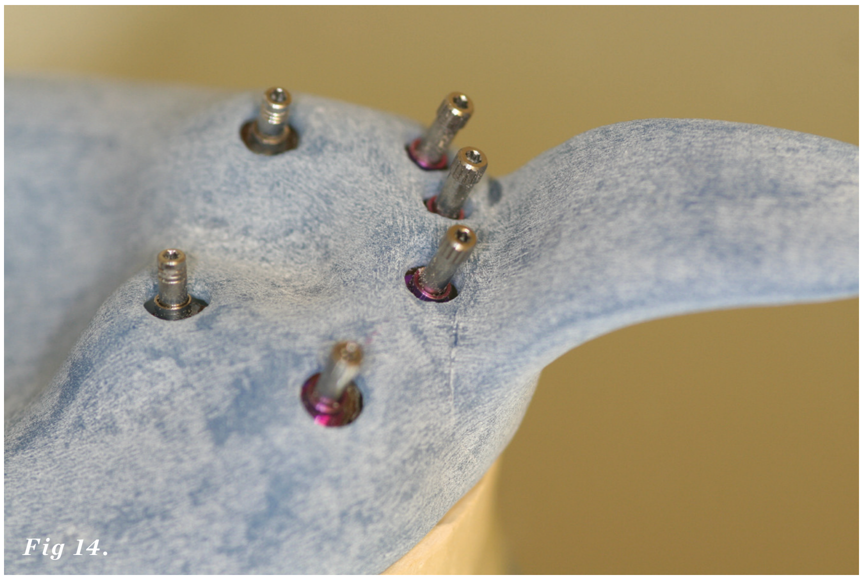

Fig 14.

be “properly adjusted” at the time of delivery, or at least very close. This is even more crucial when technology comes into play and we are attempting to reverse-engineer the case by starting with the exact size and contours of the final device in our preliminary set-up and wax-up for laser scanning. When using CAD/CAM technology, the milled titanium bar (and attachments for overdentures) can be virtually and accurately designed within those parameters.

TWO-STAGE VERIFIED IMPRESSION TECHNIQUE

Obtaining the most accurate master cast possible for CAD scanning requires reducing the amount of distortion of the various materials used in the fabrication of the cast. The following technique seems to be widely accepted and provides consistent successful results.

With the first preliminary impression, the clinician simply creates holes in a stock plastic tray (Figure 1) and makes the best impression possible. The technician then constructs a cast from that impression, retracting the impression copings from the preliminary impression, and accurately reseating them on the cast (Figure 2). Using a preformed rigid plastic bar stock for longer spans and pattern resin for short spans, everything is splinted together, creating an intraoral luting jig (Figure 3 and Figure 4). The case is then sectioned, using a thin disc, in favorable positions for clinician access and sequentially numbered (eg, R1-2-3-4-5-6L). This helps the clinician seat the device intraorally with ease and accuracy (Figure 5). The sections will then only need to be luted and splinted together with very small amounts of resin, which minimizes both patient discomfort (time and monomer intraorally) as well as distortion when the resin is polymerized. The luted jig will then be ready for an over impression using a medium/heavy body impression material. Over the course of the past 6 years, the technique and materials have evolved from GC Pattern Resin (GC America, www.gcamerica.com) (Figure 6), to GC pattern resin combined with pre-formed bar stock (Figure 7), to today’s low distortion Pi-Ku-Plast (Bredent, www.xpdent.com) and bar stock (Figure 8).

The laboratory then fabricates a precision custom tray with access holes for the impression copings that offers strong structural support for the impression material and as much extension of the screws as possible for good accessibility (Figure 9 through Figure 12). The more divergent the

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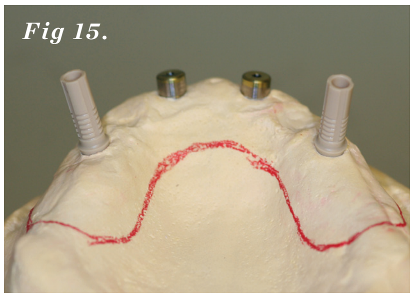


Fig 15.

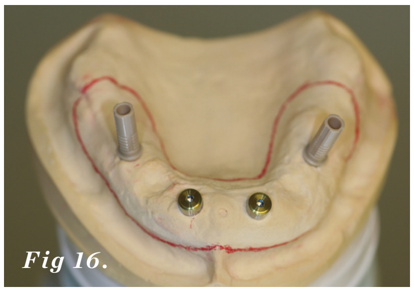


Fig 16.

Fig 17.

Fig 15. and Fig 16. The maxillary verified master cast with plastic temporary copings, replica (to intraoral) healing abutments placed, and desired extensions outlined.

Fig 17. The intaglio surface of the finished maxillary basebar. Note that the accurate vertical stops are to rest on healing caps in the area of teeth Nos. 8 and 9.

Fig 18. The topside of the maxillary basebar. Note that the bar-like ridge of light-cure material adds strength and rigidity.

Fig 19. The mandibular verified master cast with four temporary copings placed and desired extensions outlined. The outline represents the "footprint" of the basebar. However, the buccal-lingual extensions will curve up and out, not down, to contact the tissue, and create the ridge lap.

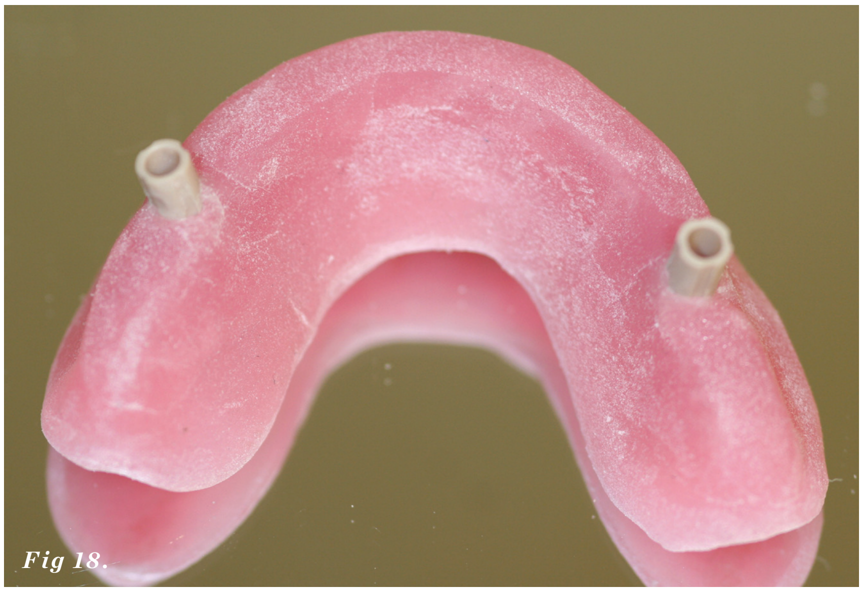


Fig 18.

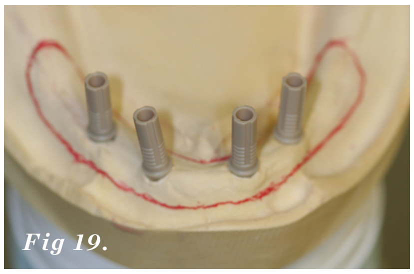


Fig 19.

shafts, the more "slop" is needed in the screw-access holes to allow for full, accurate seating of the tray (Figure 13 and Figure 14).

When the clinician returns the final verified impression to the laboratory for construction of the final verified master soft-tissue cast, use only Type IV die stone to reduce the amount of distortion that will be caused by expansion. Splinting the impression copings in the mouth not only minimizes distortion due to polymerization of the impression material, but also movement of the analogs due to expansion of the die stone as it sets. The importance of these steps cannot be overstated as the accuracy of the master cast is the single most critical factor in obtaining an accurate CAD-scanned/designed and CAM-milled implant bar that is a passive fit to minimize undesirable stress or forces on the implants.

SCREW-RETAINED LC RESIN BASEBARS

To further examine the advantages of screw-retained basebars over conventional baseplates when fabricating CAD/CAM-milled titanium bar restorations, the patient's perception needs to be understood. Patients have invested a considerable amount of time and money for implant placement, not to mention the additional cost of the restorative procedure, all to escape the "dentures in a glass" scenario. Preliminary seating of a final size/contour device that is screw-retained and "fixed" is an instant indication and gratification that the investment is already paying off. It provides the clinician with a very stable device for establishing the vertical dimension of occlusion (VDO) at the records appointment, as well as at subsequent try-in(s). The device also provides the clinician with the additional benefit of diagnosing important criteria, especially in the maxilla, that determine if a screw-retained fixed-detachable will be feasible or if an attached overdenture is indicated.

Equally important for the technician is the fact that once the clinician and patient have approved the esthetics and bite of the set-up and it is time to laser-scan the device for CAD design of the bar, the technician is working with the specific contours that are expected of the final finished prosthesis. This is important with screw-retained hybrid bars, but even more critical when the case is an attached overdenture bar where additional space must be incorporated for a cast metal reinforcement mesostructure and attachments.

When fabricating a SR basebar, temporary copings, either titanium or plastic, are incorporated onto the master cast but always non-engaging. Although this device will function properly if cylinders are installed on all of the implants, it is more economical and efficient for the clinician as well as more comfortable for the patient, if only one cylinder per quadrant is used. This eliminates the need for removal and reseating of all of the healing abutments each time the clinician must obtain records or conduct a try-in(s). However, it is critical that the clinician provides the laboratory with a set of healing abutments identical to the ones that are in the mouth, so that the basebar fits precisely and rests on top of them to provide vertical support when the device is fully seated and screwed down (Figure 15 through 18). The exception to using this technique could be for a screw-retained hybrid where there is a need to assess the divergence and screw-access holes for all of the implants and their relationship to denture teeth that will be placed in proper esthetic and occlusal position during the next step of fabrication (Figure 19).

The second key aspect of the fabrication process is properly constructed screw-retained basebars.

The desired extensions are then outlined on the cast and any undesirable undercuts blocked out with wax. This includes any space below the margins of the temporary copings and the driver holes on the top surface of any healing caps. This technique can be carried even one step further in the case of a SR-hybrid in which the clinician's preference is to have the final mandibular restoration raised a millimeter or so off the tissue to allow the patient to clean underneath the device and around the implants by adding a layer of relief wax to the ridge (Figure 20).

A sheet of light-cured baseplate resin is then carefully adapted, ensuring that the material is well attached to the cylinders. If the vertical height is limited, or if there is an unsupported cantilever extension that would be cause for concern with regard to strength and possible breakage intraorally, then a relatively new but remarkable light-cure reinforcement material, Fiber-Force (Synca Direct Inc., www.fiberforcedental.com), can be used. Because both materials are light-cured, the reinforcement tape can be wedged between two layers of the baseplate material and around the cylinders, then the two materials cured simultaneously as long as enough time and/or cycles are used to ensure a thorough curing (Figure 21 through 25).

The cured basebar is then carefully finished to the anticipated extensions of the final restoration (Figure 26 through 28) and the wax rim applied to the basebar using guide pins (chimney screws) to help create the screw shafts in the wax (Figure 29 through 32). The same guide pins can be used at the processing stage to create the same shafts in the acrylic or denture teeth in the case of a SR hybrid. (They cannot be used in processing an attached overdenture.)

The next two stages of fabrication, VDO bite records for articulation and setting of the denture teeth with esthetic wax-up for try-in will closely mimic the procedures used for conventional dentures (Figure 33 through 37). Once the clinician and patient have approved the tooth arrangement and wax contours, and additionally, for a maxillary case, agreed to the type of device that best serves the patient's esthetic,

What Should the A-P Spread Be?

With regard to distal extension cantilever distances and its relation to the A-P spread on a (multiple) implant-supported, screw-retained fixed or hybrid detachable device, there has not been a fully defined, set-in-stone formula to calculate the maximum distal extension cantilever based on actual collected scientific data. Rather, the formula for distal extension cantilever distance is widely regarded as a "range" based on several factors, including the number of implants, length of the implants, diameter, quality, and the quantity of bone surrounding the implants.

Some of the considerations in calculating this formula might go beyond the implants themselves and include the specifics of the prosthesis, such as its ability to "withstand" the vertical forces applied distally, dimensional and material strength, rigidity, and occlusal plane width. Other possible considerations might even include the type of opposing dentition the device will function against as well as the patient's age, gender, physical condition, etc.

Although considered optimal, using 0.5 times A-P spread as the absolute maximum would be considered ultra-conservative and effectively relinquish molar occlusion on many restorations.

The range most often published and widely accepted is from 0.5 to 1.5 times A-P spread, depending primarily on the number of implants that have been used. This concept was established in the 1980s and early 1990s by the research and clinical studies conducted and published by Dr. Charles E. English. English was a renowned Virginia prosthodontist who was instrumental in establishing criteria for biomechanical concerns for implant-supported prostheses. Over many years and throughout many cases, this author has worked closely and consulted with several prosthodontists who have expressed similar beliefs.

Although not a definitive proven fact, this author would submit that these concepts and formulas were formed some time ago and have not really been "updated" to reflect the increased success and technological advancements of modern-day implants structures, surfaces, screws, and techniques as well as the advanced quality of the prosthetic device's components, such as CAD/CAM-milled titanium or even chrome–cobalt bars.

The devices depicting the A-P spreads in the photographs shown in this article are not the final prostheses, but rather screw-retained base-bars (baseplates) that serve as records and diagnostic devices. The final distal extensions of the actual prosthesis (milled-titanium bar) is subject to several "checkpoints," including software recommendations during design for fabrication and final designation by the restorative clinician. (The formula used by the Nobel Procera software is 1.5 times A-P spread.) Often, the second-molar occlusion is forgone. In all cases, except those requiring the minimal number of implants, first-molar occlusion is highly desired.

This author is not qualified to disagree with academia or qualified clinicians or prosthodontists, but he can happily report that in more than 150 milled-titanium bar restorations that his laboratory has fabricated in the past 6 years, there has been no overall implant failure, prosthesis failure, or excessive screw loosening resulting from over-extension of the distal cantilevers. (At least none have been brought to his attention by any of his clients).

If there is further clinical evidence that has not been considered here, let us continue the discussion at www.facebook.com/InsideDentalTechnology.

phonetic, lip support and hygienic requirements, the laboratory is then ready to laser-scan the verified master cast for implant position, tissue, and the device itself (Figure 38 and Figure 39).

These images are then married to provide the 3D virtual screen that is used to properly design and position the bar (as well as attachments in an overdenture) within the parameters of the device (Figure 40). This allows the bar to be milled in a very precise and predictable fashion. When the reverse-engineered milled bar is returned for final assembly and processing, all the components fit together in harmony with no surprises or obstacles to overcome.

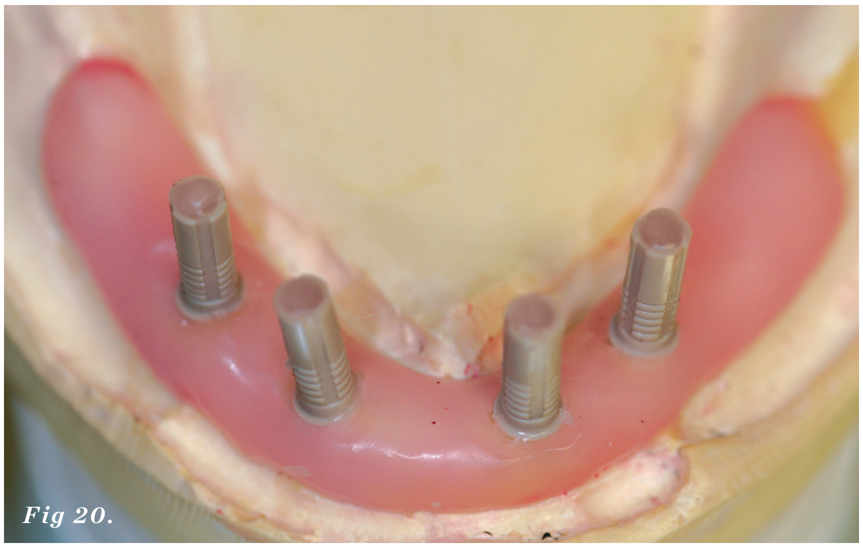


Fig 20.

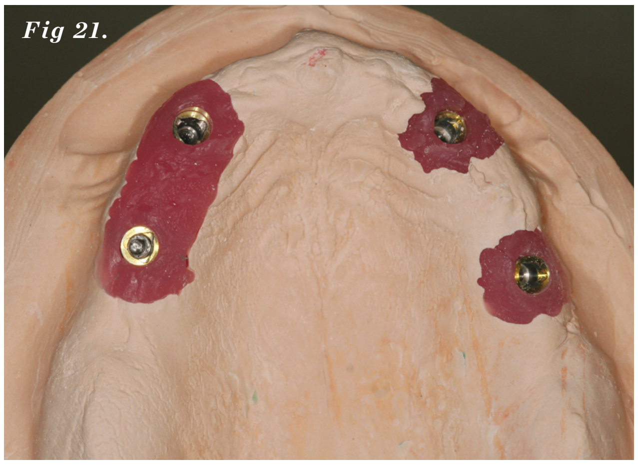
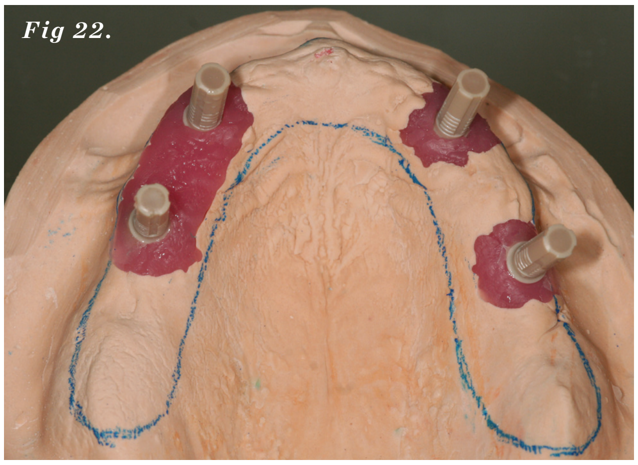


Fig 21.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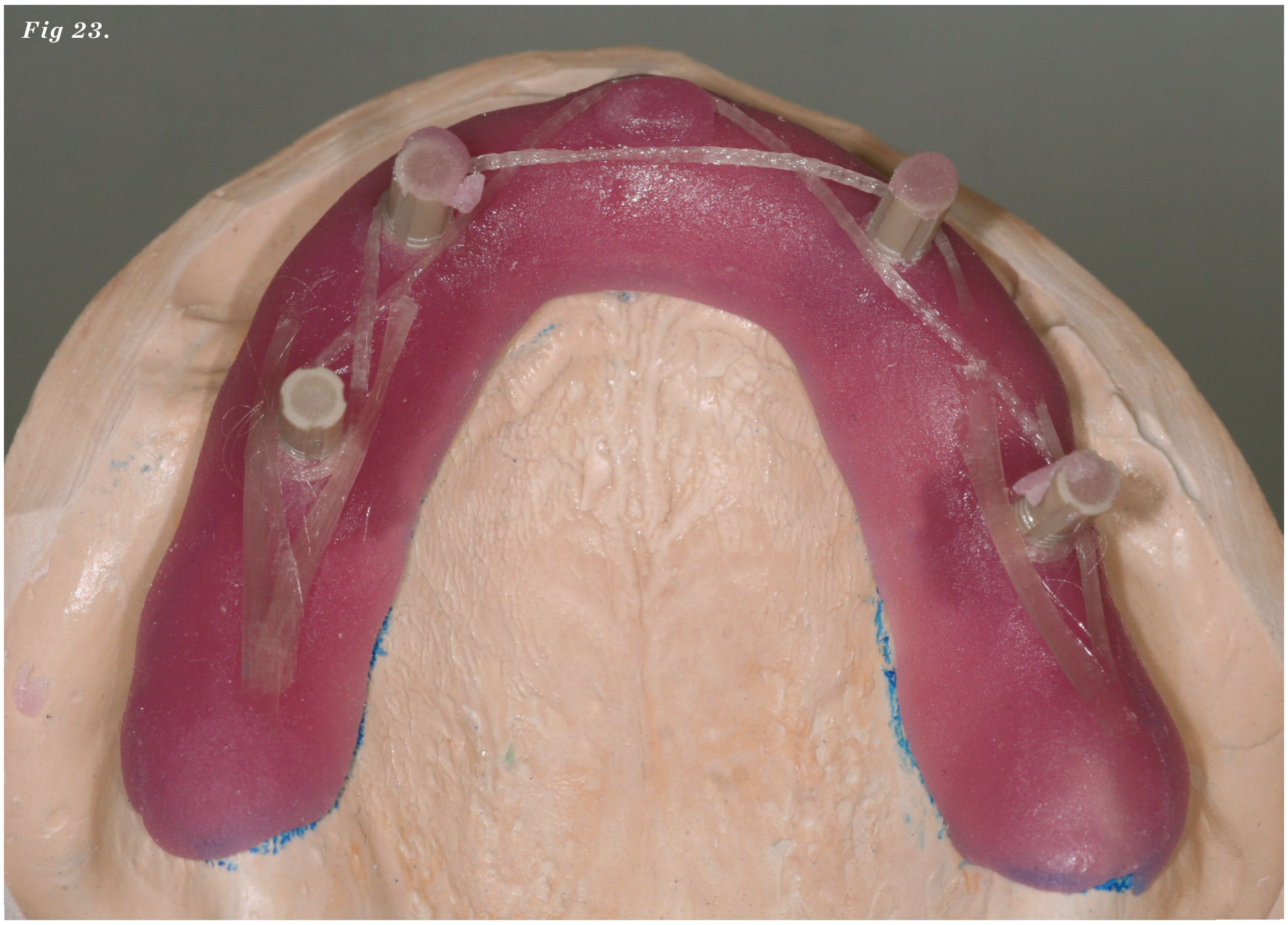
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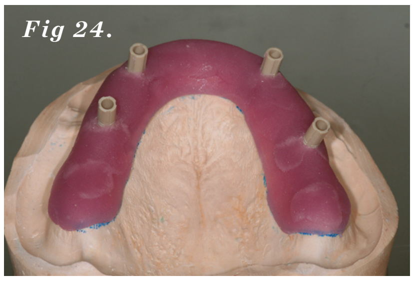
Fig 24.


Fig 25.

Fig 20. A wax shim (1 mm) is placed as a relief to obtain a basebar that sits off the tissue as expected in the final prosthesis.

Fig 21. and Figure 22. The maxillary verified master cast with temporary copings placed and desired extensions outlined. Note the tops of the temporary cylinders are filled with wax to prevent the light-cure material from filling and/or sealing shut.

Fig 23. Light-cure baseplate material is formed. Because of long spans and extensions as well as anticipated limited vertical, Fiber-Force reinforcement tape is incorporated.

Fig 24. The second layer of light-cure material is added to “embed” the reinforcement tape prior to curing the two materials simultaneously.

Fig 25. The basebar light-cure and Fiber-Force material are cured simultaneously.

Images continue on page 38 and page 40 ›

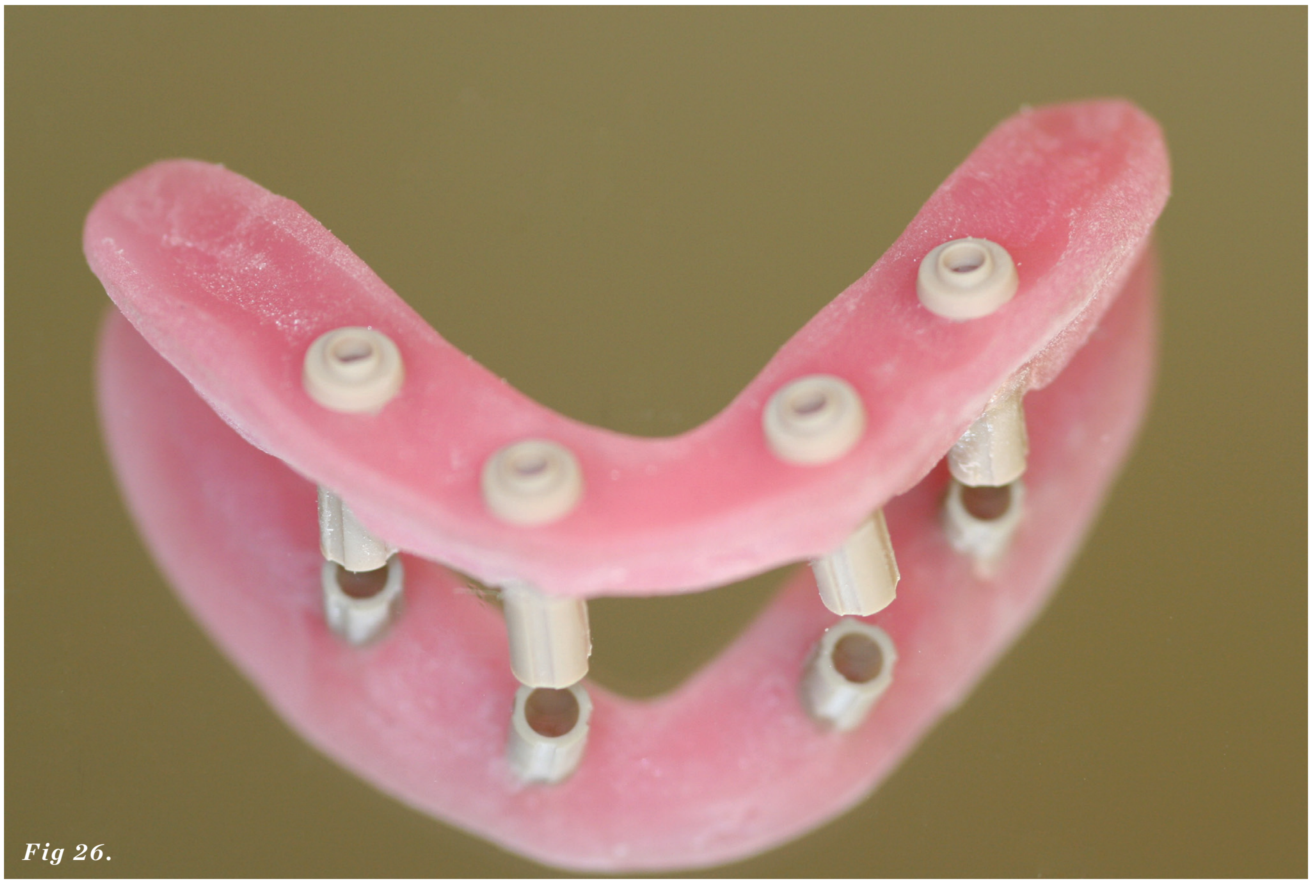
Fig 26.

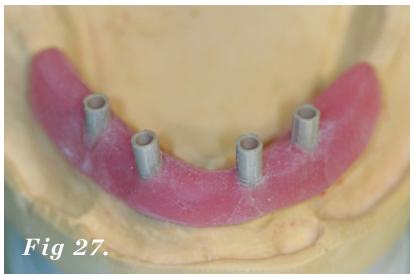
Fig 27.

Fig 26. through Fig 28. These properly cured and finished basebars are ready to receive wax rims.

Fig 29. through Fig 32. The finalized basebars with wax rims are ready for the VDO records appointment. Note that the screw-access holes are created with the use of guide pins (chimney screws).

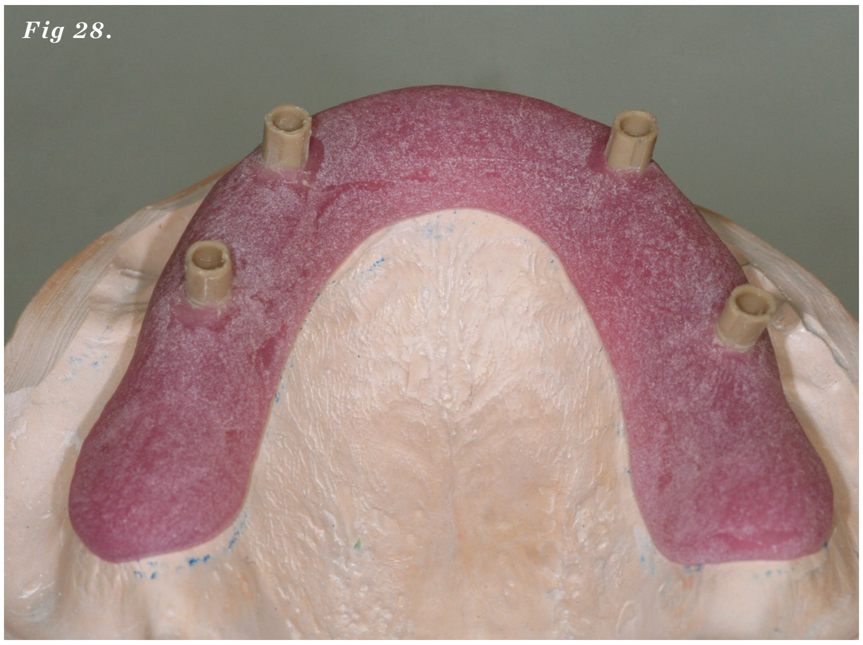
Fig 28.


Fig 29.


Fig 30.


Fig 31.


Fig 32.

Fig 33.

Fig 34.

Fig 35.

Fig 36.

Fig 33. through Fig 35. The finalized set-ups/wax-ups are ready for clinical try-in and patient approval prior to scanning for bar fabrication.

Fig 36. The matrix-jumped set-up/wax-up on the MT bar ready for final try-in and patient approval prior to injection processing and finishing.

Fig 37. The finished mandibular SR hybrid denture with two palatal Branemark 42.5-mm zygomatic implants. Note: Because of the palatal position of the implants, the bar had to extend out of the arch form/body of the device to interface with the implants.

Fig 38. The patient-approved set-up ready for laser scanning.

Fig 39. The set-up is sprayed with an opaque powder to accurately reflect the laser beam during the scanning process.

Fig 40. A virtual 3D screenshot of the bar design within the parameters of the prosthesis.

Fig 37.

Fig 38.

Fig 39.

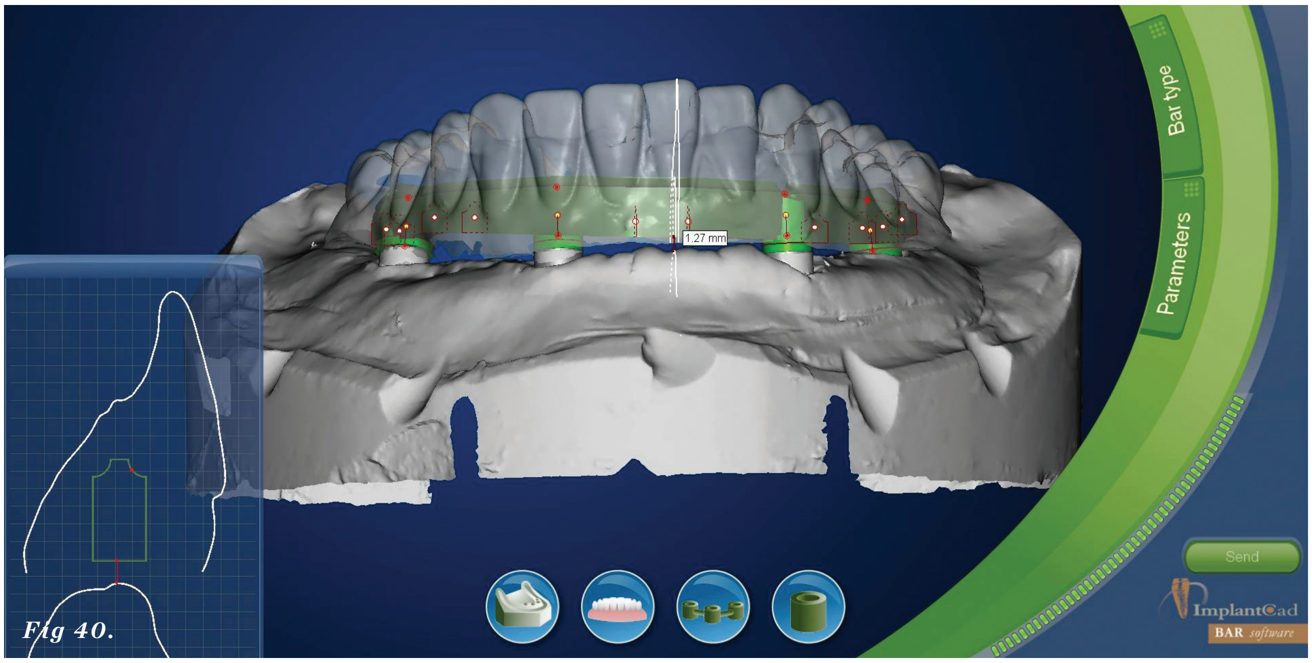

Fig 40.