The Role of Abutment-Attachment Selection in Resolving Inadequate Interarch Distance: A Clinical Report

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A critical factor that needs to be evaluated during the diagnosis and treatment planning phase for patients seeking an implant-tissue-supported overdenture or metal-resin implant fixed denture is the presence of adequate interarch distance. The amount of interarch distance is critical to the selection of appropriate implant abutments and attachments for both implant-tissue-supported overdentures and metal-resin implant fixed complete dentures. This clinical report describes a patient with complications related to the failure to diagnose inadequate interarch distance, and the methods used to resolve the patient's chief complaint. A guide for abutment-attachment selection using one commercially available implant system is given.

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REHABILITATION of edentulous patients with implant-tissue-supported overdentures and rehabilitation with metal-resin implant fixed complete dentures[1] have very good success rates,[2–7] and consequently can be prescribed for patients on a routine basis. Through proper diagnosis and treatment planning, the prosthetic therapy can be completed with minimal complications. The patient's desired level of esthetics, desired level of prosthesis retention, existing anatomy, phonetics, hygiene maintenance capability, and cost considerations all aid in treatment planning.

During the diagnosis and treatment planning phase of therapy, an accurate spatial determination between the maxillary and mandibular dental arches is critical to the overall outcome of care.[8] The presence of adequate interarch distance is a prerequisite for the prosthetic success. Interarch distance dimension must be clearly visualized and accurately measured prior to implant placement. Various techniques can be employed early during the diagnosis and treatment planning phase to assess and accurately calculate the available interarch distance at the correct vertical dimension of occlusion. These include:

1. assessment of properly articulated diagnostic or master casts,
2. diagnostic waxing of the planned prostheses,
3. evaluation of existing interim or immediate conventional dentures.

The following clinical report describes treatment for a patient who was initially restored with inadequate interarch distance and experienced subsequent prosthetic failure.

Clinical Report

A 67-year-old female patient presented to the UNC Graduate Prosthodontics clinic with a chief complaint of recurrent fracture of the maxillary

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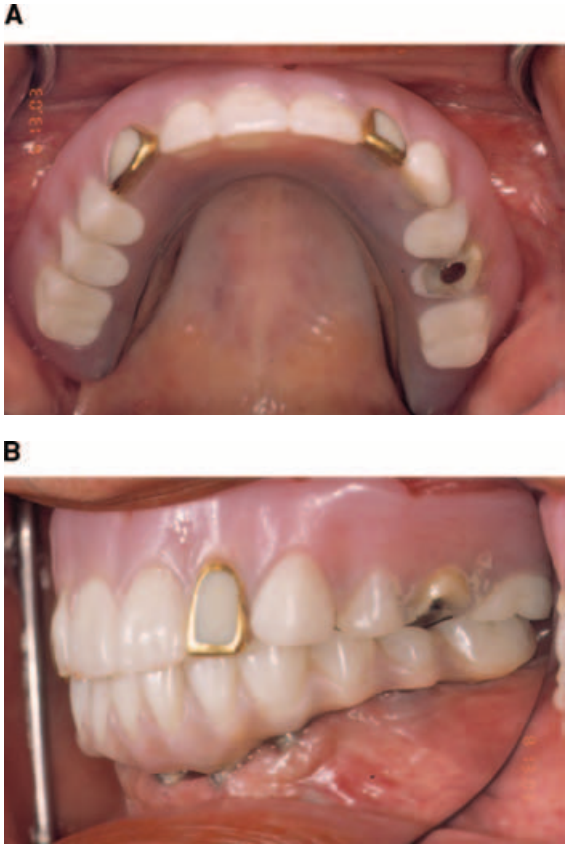

Figure 1. (*A*) Fractured second premolar acrylic denture tooth in maxillary implant-supported overdenture. (*B*) Inadequate vertical intermaxillary space is evident.

second premolar acrylic denture tooth over the left terminal attachment of a maxillary implant-tissue-supported overdenture (Fig 1A).

The maxillary implant-tissue-supported overdenture opposed a mandibular metal-resin implant fixed complete denture. Four Microthreaded™ endosseous dental implants (Astra Tech, Inc., Lexington, MA) supported the maxillary overdenture, two measuring 3.5 × 13 mm, and two measuring 4.5 × 13 mm ST. The mandibular metal-resin implant fixed complete denture was supported by six Microthreaded® implants with three measuring 4.5 × 13 mm ST, one measuring 3.5 × 15 mm, and two measuring 4.0 × 15 mm ST. The maxillary overdenture prosthesis was retained with Ball abutments (Astra Tech, Inc.) and the standard Dalla Bona gold cap attachments (Cendres & Metaux SA, Biell/Bienne, Switzerland). The mandibular implants used six 20° UniAbutments of varying soft tissue heights to secure the screw-retained prosthesis.

The earliest tooth fracture occurred 1 week following delivery of the maxillary prosthesis. Multiple repairs over a 12-month period failed to solve the patient's chief complaint. Upon thorough examination, a lack of interarch distance, which consequently lead to inadequate clearance for the selected implant and prosthetic components, was detected. Figure 1B shows the lack of space between the mandibular prosthetic tooth and the Dalla Bona attachment beneath the denture tooth replacing no. 13. This compromised prosthetic success and jeopardized treatment outcome and patient satisfaction with the prostheses and therapy.

A new treatment plan was developed not only to replace both prostheses, but also to change selected implant abutments and attachments to provide additional interarch distance at the existing vertical dimension of occlusion, which had been clinically assessed as accurate. These changes were carried out as follows:

Abutment (Patrix) Selection

For the implant system used, all the prosthetic abutments will fit into the 3.5, 4.0, and 4.5 ST implants; however, they insert to different depths. For this patient scenario, the tissue heights were equivalent, and the patient did not wish to increase interarch distance by hard or soft tissue surgical removal. Thus, changing tissue heights of the abutments would not provide additional interarch distance. Changing the type of abutment could increase the amount of interarch distance, however. Therefore on the mandibular terminal implants, both 20° Uniabutments were replaced with 45° Uniabutments. This change provided an additional 1.35 mm of interarch distance for abutments with identical tissue heights (Fig 2).

For the maxillary overdenture, the patient's left terminal implant abutment beneath tooth no. 13, which was chronically fracturing, was changed from a Dalla Bona abutment ST to a Zest Locator abutment (Zest Corperation, Escondido, CA) of the same tissue cuff height (3 mm). This change resulted in an interarch distance net gain of 2.12 mm (a combination of reduced height of the abutment and attachment) (Fig 3).

Thus, for the opposing implants at site no. 13 and site no. 20, a net gain of 3.47 mm was achieved merely by changing components.

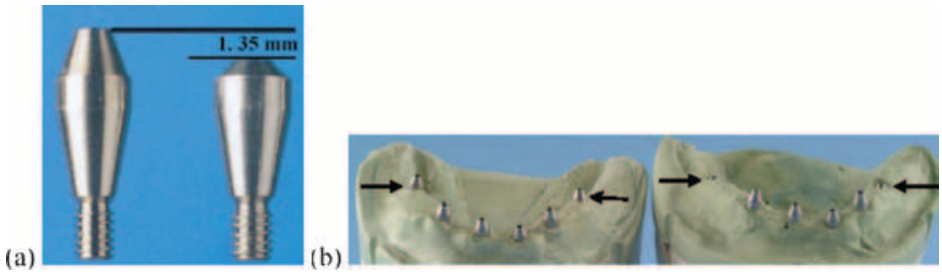

Figure 2. (*A*) UniAbutments (20° vs. 45°). (*B*) Mandibular master casts with 20° terminal UniAbutments (left cast) replaced with 45° UniAbutments (right cast).

Abutment Screw Selection

For this implant system, both slotted and internally hexed bridge screws are available. The patient was originally restored with the hexed bridge screws retaining the mandibular metal-resin implant fixed complete denture; however, the slotted screw was used in the final prosthesis, which provided an additional 1.0 mm of interarch distance (Fig 4). All screws were torqued to 10 Ncm after prosthesis delivery, as per manufacturer's recommendations.

Framework Design Modification and Casting Alloy Selection

Additional interarch distance can be obtained by designing the metal framework for the metal-resin implant fixed complete denture with limited to no space available between the intaglio surface of the prosthesis and the crest of the alveolar ridge, especially in the distal segments. This distal segment may lightly, but passively, contact mucosa in the manner of a tissue contacting the pontic of a conventional fixed partial denture, provided there is access for hygienic maintenance.[9] Additionally, the highly smoothed, polished, and rounded metal can form the tissue contacting surface, and having metal-acrylic resin finish lines facial and lingual to the ridge, rather than completely wrapping the most distal segments in acrylic resin, is often prescribed. This provides more of an I-beam effect with potentially reduced metal in the areas that require the additional strength. Potentially, modifying the framework design in this manner may save an additional 1–2 mm of interarch distance. Finally, the clinician can prescribe the use of an alloy with relatively higher elastic modulus (Type IV—extra hard—high noble alloy rather than low-gold Ag-Pd or High-Pd alloys), which may allow the fabrication of framework with reduced occluso-gingival dimension without a reduction in strength.[10] The recommended occluso-gingival dimension for Type IV—extra hard—high noble alloy is 3.5 mm[11] and for low-gold, high-palladium alloys, 6 mm[12] (Table 1).

Figure 3. Ball Abutment and Zest Anchor.

In some cases where minimal bone resorption has occurred, fixed ceramo-metal restorations might better accommodate interarch space limitations and provide optimal esthetic, phonetic, and hygienic access.[5] Congruence of implant and prospective tooth position is a prerequisite for such a treatment modality.[13] Treatment costs can be a deterring factor in this scenario. In situations where there is severe space limitation, it has been advocated by some that it is best to avoid implants in the incisor region to allow an esthetic ridge lap of the pontics.[14]

Figure 4. Screw types: slotted (left) versus internal hex design (right).

Attachment (Matrix) Selection

For the maxillary implant-tissue-supported overdenture, several choices are available for the Astra Tech implant system. For use with the Ball abutments (Astra Tech, Inc.), as originally prescribed for the patient, the clinician has the option of using the Gold Cap (Dalla Bona) attachment (Cendres & Metaux SA), or the Preci-Clix attachment with the metal TITANAX® attachment (Preat Corporation, Santa Ynez, CA). However, for the ball abutment, the Preci-Clix attachment only provides a gain of 0.3 mm in interarch distance (Fig 5).

Converting the Ball abutment to the Zest Locator (Zest Cooperation, Escondido, CA), however, provided a total reduction in interarch distance of 2.12 mm. For this reason, the Locator abutment and its respective attachment were selected for restoring the implant on site no. 13 (Fig 6).

By remaking the maxillary implant-tissue-supported overdenture using the Locator abutment-attachment on the terminal implant (site no. 13), by remaking the mandibular metal-resin implant fixed complete denture using 45° UniAbutments and slotted screws on the terminal implants, and by redesigning the metal framework to provide minimal tissue clearance on the terminal segments and metal on the intaglio surface, sufficient interarch distance was obtained to allow the vertical dimension of occlusion to be maintained, and the prosthetic teeth to be placed with sufficient vertical thickness to minimize fracture or debonding from the prosthesis base. The patient was restored in this manner and

Table 1. Vertical Heights Required for Abutment, Attachment, and Prosthetic Components Selected for Implant-Tissue-Supported Overdenture and Metal-Resin Implant Complete Denture*

Components	*Vertical Height (mm)*
Abutments (Patrix)	
Ball Anchor, in 3.5 mm Microthreaded implant	4.57
Ball Anchor, in 4.0 mm Microthreaded implant	3.27
Ball Anchor ST, in 4.5 mm ST implant	3.57
UniAbutment 20°, taper top height	2.15
UniAbutment 45°, taper top height	0.8
Zest Locator, for Astra Tech implants	2.0
Attachment thickness (matrix)	
Gold cap attachment	1.3
Preci-Clix TITANAX attachment	1.0
Zest Locator attachment	0.75
Prosthetic components	
Minimum required denture base resin thickness	2.0
Minimum prosthetic tooth O-G height	3.0
Metal framework thickness, Type IV high noble[11]	3.5
Metal framework thickness, low gold, high Pd[12]	6.0
Bridge screw, slotted, head height	1.0
Bridge screw, internally hexed, head height	2.0

*Assuming soft tissue depth above the implant is equal—in this case it measured approximately 3 mm from the implant top. Implant components are for Astra Tech system (Molndal, Sweden) unless indicated otherwise. Also note that different abutments insert at different levels into the Astra implant threads.
O-G = occlusal gingival; Pd = palladium; ST = single tooth.

Figure 5. Astra Tech Gold Matrix versus Preci-Clix attachment.

has functioned for the last 12 months without subsequent complications (Fig 7).

For the dental implant system used in the treatment of this patient, a list of the various prosthetic components is provided to allow the clinician to appropriately choose the components for when a patient presents with a given interarch distance (Table 2).

Figure 6. Ball retentive anchor versus Locator abutment with respective attachments.

Discussion

In the patient described in this clinical report, it appears that improper diagnosis of the available interarch distance was made initially. Assessing the patient's panoramic radiograph (Fig 8), it appears that the patient had an abundant mandibular edentulous ridge, or said differently, minimal residual ridge resorption following tooth extraction had occurred. It may have been appropriate to consider a surgical correction to reduce the vertical height of the residual alveolar ridge prior to or during implant placement rather than risk the prosthetic complications in this patient. Clearly, once the implants have been surgically placed, and osseointegration has occurred, the options for patient treatment in a reduced interarch distance scenario become limited.

Selection of implant abutments and prosthetic attachments should be made during diagnosis and treatment planning rather than after clinical problems have occurred. Early consultation with the implant surgeon in patients with the potential for reduced or inadequate interarch distance is critical to the outcome of implant therapy. The use of a surgical guide fabricated from a diagnostic wax-up or provisional denture set-up can direct the surgeon in proper placement of the implants. Properly constructed surgical templates not only direct the facio-lingual and mesio-distal location of the implants, but also provide the surgeon with a clear indication of the depth of implant placement, which plays a key role in the provision of adequate interarch distance.

While multiple abutment types exist for this and other implant systems, often they are selected based on the clinician's preference, or the perceived ease of long-term maintenance, rather than on sound prosthodontic principles. For example, while the gold cap attachment frequently requires activation to improve the retention level (due to metal fatigue of the attachment), other types, such as the Preci-Clix male retention cap or Zest Locator nylon attachment, may not. However, the gold cap attachment can undergo multiple adjustments, while the elastic-plastic types will require replacement when the retention is lost. Preci-Clix attachments are available in three color-coded levels of retention: standard (yellow), decreased (white), and increased (orange) retention. However, long-term maintenance data for these systems are currently lacking. Clearly, in an

Figure 7. Frontal view of patient with initial prostheses (left) and final prostheses (right).

area of inadequate interarch distance, selection of components with reduced vertical height is an advantage to the clinician.

A brief assessment should be made of the requirements for the occlusal-gingival (O-G) height of the prosthetic denture tooth and denture base material, a dimension below which success rate is compromised. The minimal vertical dimensions for these components of the prostheses is 2.0 mm for the denture base thickness between the metal framework of the metal-resin implant fixed complete denture and the ridge lap portion of the prosthetic tooth, and 3.0 mm for the prosthetic denture tooth, measured from the central groove area of posterior tooth to the adjusted ridge lap surface.

Philips et al recommended that a prosthetic denture tooth be about 3 mm above the lingual base acrylic resin.[15] In a separate publication, Phillips stated that 3 mm is required from the lingual acrylic to the incisal edge of the denture tooth.[16]

The minimal dimension of these materials should not be compromised due to the likelihood of fracture or debonding of either the prosthetic or implant components.

Conclusions

In this clinical report, it is apparent that careful analysis of the maxillo-mandibular relationship of the edentulous arches is critical in determining the available interarch distance. Implant prosthodontics requires a teamwork approach where the prosthodontist or restorative dentist, through proper diagnosis and treatment planning, provides the implant surgeon with clear instructions regarding the number, location, spatial orientation, and depth of implant placement relative to the proposed occlusal plane and prosthetic tooth position. These instructions culminate in the fabrication of a well-constructed surgical guide to properly execute the intended therapy. Early in the treatment phase, reduction of the residual alveolar ridge should be considered and performed, if necessary, to provide sufficient interarch distance.

Table 2. Comparison of Ball Anchor Versus Zest Locator for ASTRA Tech Implants

ASTRA Tech Implant Type	4.5 ST	3.5	4.0
A. Uniball Abutment Height by implant type*	2.87 mm	2.85 mm	2.85 mm
B. Uniball Mucosal height (3.0 mm tissue cuff)*	0.7 mm	1.7 mm	0.4 mm
C. Total abutment height (A − B)	3.57 mm	4.55 mm	3.25 mm
D. Zest Locator Abutment Height**	2.0 mm	2.0 mm	2.0 mm
E. Height Difference (Astra − Zest)	1.57 mm	2.55 mm	1.25 mm
F. Housing Thickness (Dalla Bona)	1.3 mm	1.3 mm	1.3 mm
G. Housing Thickness (Zest Locator Titanax)	0.75 mm	0.75 mm	0.75 mm
G. Difference in Housing Thickness (F − G)	0.55 mm	0.55 mm	0.55 mm
H. Total Vertical Interarch Space Gain (E + G)	2.12 mm	3.05 mm	1.8 mm

*Reference: ASTRA Tech data folder (leaflets/brochures/flyers).
**Reference: Personal communication with Zest Anchor Company (Locator Attachment Specialist).
(All dimensions were verified by measuring them in the dental lab using Boley gauge, periodontal probe, or other measuring devices).

Figure 8. Initial panoramic radiograph.

Accurate abutment-attachment selection is key to treating patients who present with inadequate interarch distance. Through the following calculated measures, it made treatment of this particular clinical case feasible:

1. Replacement of the Ball abutment with a Zest Locator abutment, and its attachment on the terminal implant of the maxillary overdenture prosthesis, resulted in an interarch distance gain of 2.12 mm.
2. Replacement of the gold cap attachments with the Preci-Clix attachments resulted in an interarch distance gain of 0.3 mm.
3. Replacement of the 20° UniAbutments with 45° UniAbutments on the terminal mandibular implants resulted in an interarch distance gain of 1.35 mm.
4. Use of slotted screws replacing internally hexed bridge screws for the mandibular prosthesis resulted in an interarch distance gain of 1 mm.
5. The space between the metal framework and the alveolar crestal tissue was minimized without compromising the space necessary for daily hygienic measures.
6. Proper design of the metal frame and the use of a dental alloy with high elastic modulus (type IV high noble alloy) provided adequate interarch distance to prevent the fracture of the prosthetic denture teeth and solve the patient's chief complaint.

The cumulative net gain of interarch distance was at least 4.77 mm merely achieved by changing the abutment-attachment components.

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