Alternative Framework Design Concepts for the All on 4™ solution.

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The predictability of successful osseointegrated implant rehabilitation of the edentulous jaw as described by PI Branemark introduced a new era of management for the edentulous predicament. Implant rehabilitation of the edentulous patient re- mains one of the most complex restorative challenges because of the number of variables that affect both the esthetic and functional aspect of the prosthesis.

The routine treatment for edentulism has been complete dentures.

Epidemiological data has reported that the adult population in need of 1 or 2 dentures would increase from 35.4 million adults to in 2000 to 37.0 million adults in 2020; and the researchers warn that their estimates may be "significantly conservative.

Clinical studies have reported that patients with dentures have shown only a marginal improvement in the quality of life when compared with implant therapy. The common reasons for dissatisfaction in patients using dentures are pain, areas of discomfort, poor denture stability and difficulty eating as well as lack of or compromised retention capability.

Treatment planning of edentulous patients with fixed restorations on dental implants has undergone a paradigm shift since the introduction of graft-less solutions.

Today, patients have options whereby in the right indication complete rehabilitation can be accomplished by the use of four to six implants per arch. The huge advantage of this procedure is reduced number of implants and the ability to bypass extensive grafting procedures. This rehabilitation not only satisfies esthetics and function but also considerably reduces costs for the patient. This ultimately results in increased patient acceptance and an increased number of patients treated. Very few patients today are able to afford extensive implant rehabilitations on six to eight implants and the All on 4™ or graft-less protocol is gaining popularity as being the preferred treatment for the edentulous patient.

In a world environment where the numbers of edentulous patients are increasing, there are not enough available dentists trained in these protocols to be able to treat them. Patients are not given these options because of the dentist's reluctance to offer them. Reasons for this are lack of education and the notion that these treatment protocols are not predictable. Delivering graft-less protocols requires attention to detail from a surgical, prosthodontics and laboratory perspective. Only through adequate education and training will the results compare to published date using conventional protocols.

Patient that present with a terminal dentition seek solutions that involve fully implant supported fixed restorations. From prosthodontic and esthetic standpoints these patients present with teeth that are in unfavourable positions. Patients with missing posterior teeth are often diagnosed as having lack of posterior support. With this diagnosis a presentation of splayed, supra-erupted teeth often results. Both of these events may be physiological or pathological and coupled with dento-alveolar compensation.

Dento-alveolar compensation is the process in which the housing around the tooth will undergo compensatory changes in order to maintain occlusal contact with the opposing dentition. As a result of these changes a lack of restorative space often results. Adequate restorative space is critical, and guide- lines exist depending upon the type of prosthesis being treatment planned. There must be adequate space for bulk of restorative material that also permits a prosthesis design to establish esthetics and hygiene. If space is limited, re-establishing a patient's vertical dimension, altering the opposing occlusion or alveolectomy should be considered.

With the increasing use of graft-less protocols, implants are often placed where the available bone is. As a result, the trajectory of the screw access is often in an unfavorable position. Even in situations where pre-angled abutments are used the clinician is often faced with the difficult situation

of designing a framework and restorations to satisfy the requirements of esthetics, biomechanics and long term function.

This article will present an alternative framework design for the All on 4™ solution.

A patient presented seeking replacement of her existing restorations. These restorations had been fabricated according to the all on 4™ protocol. Both maxillary and mandibular restorations were acrylic resin/titanium prostheses. Her chief complaint was the horizontal ledge present in her maxillary prosthesis (Fig 1).

Poor emergence profile can occur as a result of too shallow an implant placement or restoration at abutment level when there is lack of restorative space. It is the authors opinion that the additional room gained by restoring directly to the head of the fixture in the All on 4™ protocol is advantageous in being able to gain space for contouring the restoration so that an appropriate emergence profile exists. In this particular patient presentation, the implants were placed at an angle that would be un-restorable for a screw-retained restoration if the esthetic concerns of the patient were to be satisfied (Fig 2). The implants had also been placed too shallow. If the situation had been corrected with pre-angled abutments two problems would arise.

1. Lack of restorative space compromising the biomechanics of the restoration
2. Display of metal from the facial surface.

An alternative type of bar was designed to address these particular concerns

Splinted impressions were made at abutment level for the posterior implants and at implant level for the anterior implants. Master casts were verified and a wax try in performed (Fig. 3). This try in confirmed jaw relation records and communicated esthetic parameters to the patient. Lip support was evaluated and accepted. Based on the denture set up a milled provisional restoration was fabricated (Fig. 4). The provisional was tested in the patients mouth for three months prior to fabrication of the definitive prosthesis. The access holes for the misaligned implants were covered using composite resin. (Figs. 5,6)

Fig. 1: Horizontal ledge present in Maxillary prosthesis

Fig. 2: Anterior implants placed too shallow and in non ideal angulations compromising restorative space.

Fig. 3: Wax Try in to verify esthetics and contours

Fig. 4: Milled provisional restorations fabricated, note position of access holes

Fig. 5: Access holes covered using composite resin

Fig. 6: Esthetics and Phonetics verified

Fig. 7: A primary titanium bar corrects the anterior implant angulation

Fig. 8: A secondary zirconia suprastructure in monolithic zirconia and designed for minimal layering of ceramics

The definitive restoration had to satisfy a few criteria

- Correction of the mis-aligned implants
- Be 100% retrievable
- Provide support for the cantilever.

The definitive restoration (Diamart Implant solutions™), was fabricated using

A. Titanium bar for primary splinting of the implants and support of the cantilever in zirconia (Fig. 7)
B. Zirconia Suprastructure for strength and esthetics (Fig. 8)
C. Minimal layering for maximal esthetics. (Fig. 9)

Laboratory considerations for design

There are specific design requirements for fabrication of such a specific bar.

The design must maximise the strength of each material. The minimum dimensions (Fig. 10) have to be satisfied.

The design takes advantage of the fit of the titanium bar and the esthetics and strength of the zirconia. The zirconia superstructure is screwed onto the titanium base using multi-unit abutment prosthetic screws. Within the zirconia substructure are titanium inserts so when torque is applied it is distributed to the titanium inserts rather than the zirconia. (Fig 11) The titanium inserts must incorporate retentive features, have sufficient height and be conical to allow easier cementation within the zirconia structure. These ultimately will be cemented with a resin cement.

The laboratory must receive the following from the clinician in order to fabricate the definitive restorations

1. Accurate splinted impressions – The technician pours the impressions and fabricates a master cast. The technician will also provide a verification jim and a two piece occlusal rim for jaw relation records.
2. Jaw relation records – technician will do an ideal diagnostic denture tooth set up
3. Denture tooth try in and verification of jaw relationship records.
4. Fabrication of acrylic prototype. The clinician will verify contours incial edge position and occlusion.

The acrylic prototype is scanned and a titanium substructure is digitally subtracted from it.(Fig 12) It must have specific dimensions and an undersurface which is convex. The same scan is used to mill a zirconia suprastructure which is minimally cut back for porcelain application. The definitive restoration is designed to

Fig. 9: Layering of ceramics to maximize esthetics

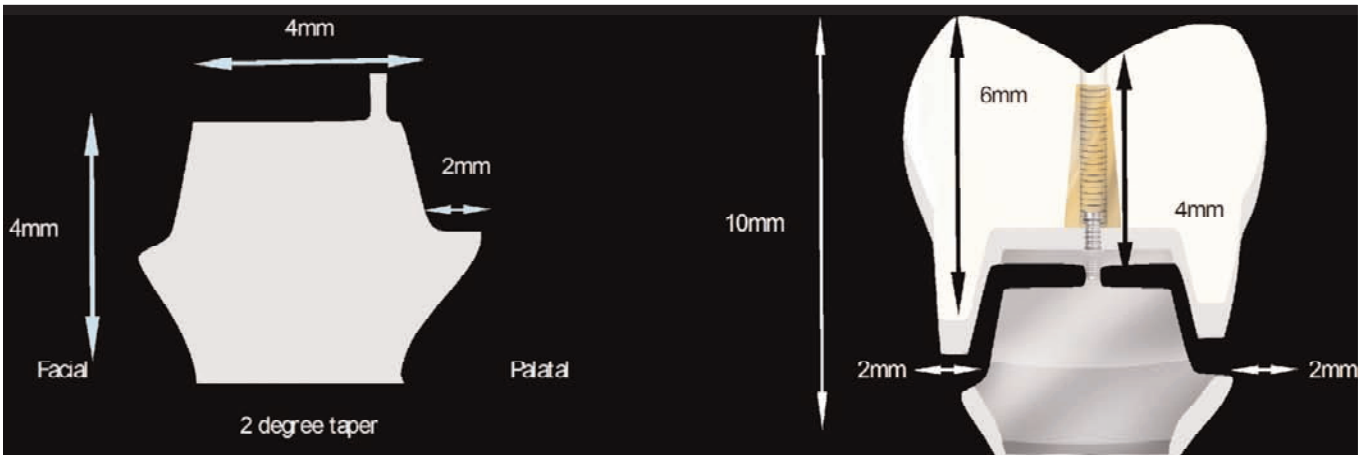

Fig. 10: Minimum dimensions have to be satisfied.

Fig. 11: There are titanium inserts within the intaglio of the zirconia suprastructure so that when torque is applied it is distributed to the titanium rather than the zirconia.

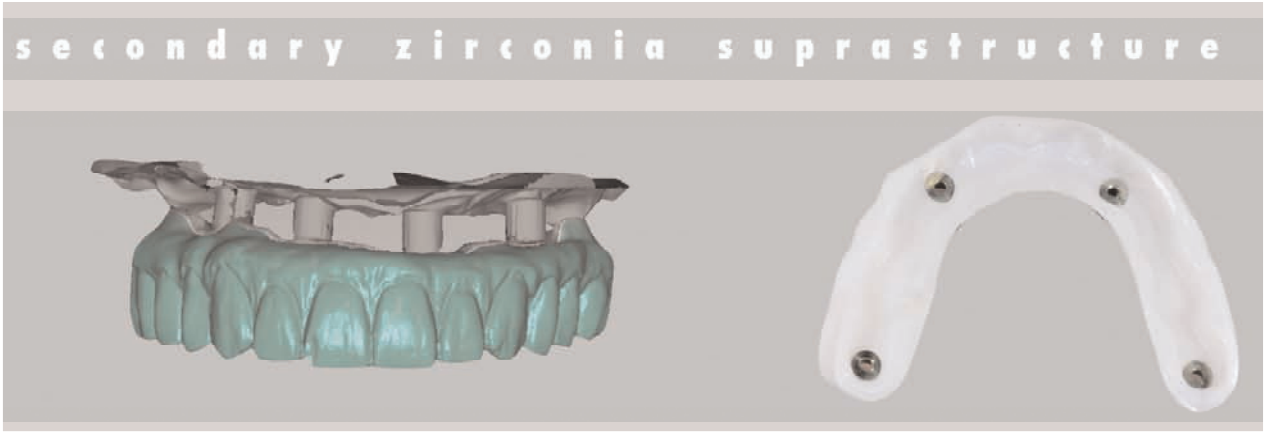

Fig. 12: Acrylic prototype is scanned and Zirconia suprastructure is milled.

Fig. 13: After final clinical try in Titanium inserts are bonded

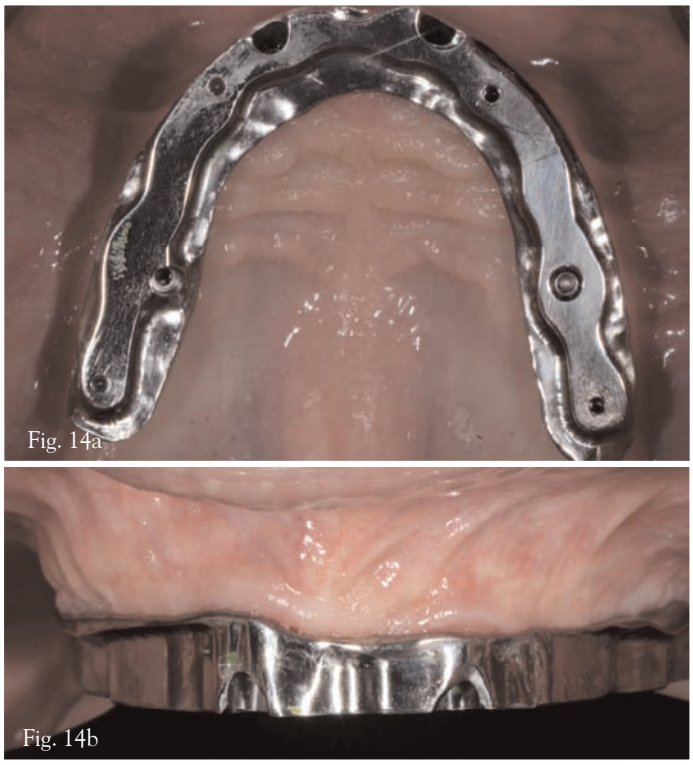

Fig. 14a: Primary Titanium bar in place
Fig. 14b: Close adaptation of the bar with the tissue

have occlusion in monolithic zirconia and minimally layered with ceramics for maximum esthetics.

A final clinical try in is performed to ensure patient satisfaction prior to the titanium inserts being definitively luted into the zirconia suprastructure (Fig 13)

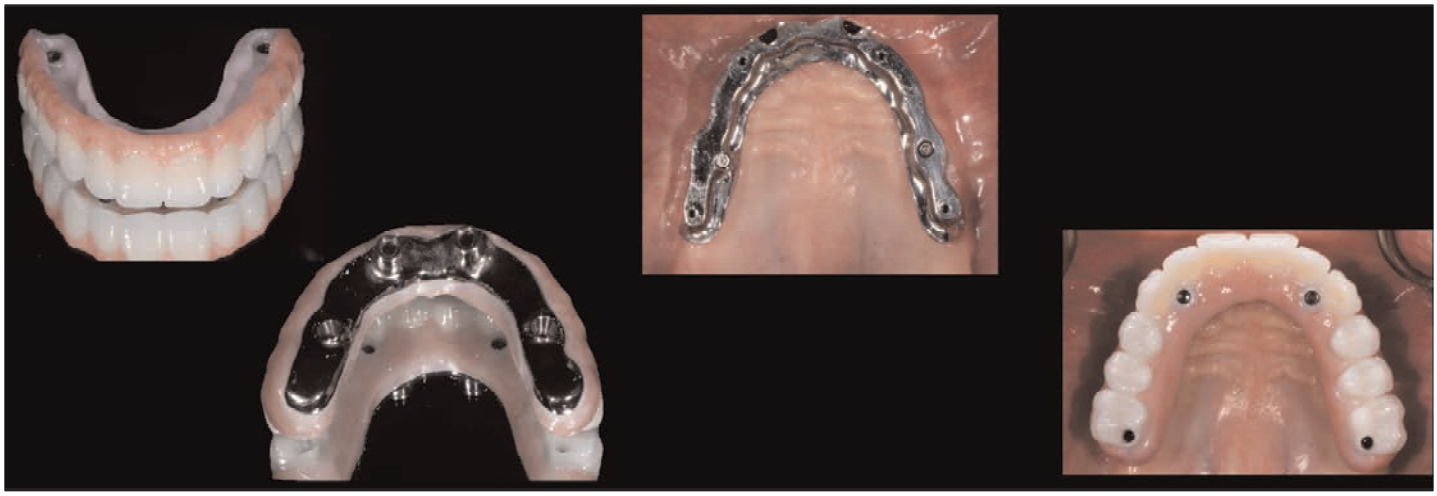

Fig. 15: Try in of Zirconia suprastructure on top of titanium bar

Fig. 16: Delivery of definitive prosthesis

At the delivery appointment the titanium substructure is delivered and screws torqued according to manufacturer recommendations, there will be a 0.5mm compression of the tissue by the titanium substructure.

The zirconia suprastructure is also screwed in and screws torqued according to manufacturer recommendations. (Figs. 14,15,16,17)

There should be minimal or no occlusal adjustment at this appointment since the occlusion has been verified at many stages.

The Diamart Implant Bridge™ has many advantages

1. It combines the fit of titanium with the strength and esthetics of zirconia
2. The titanium substructure supports the cantilever
3. The primary bar allows correction of any implant trajectory
4. The restoration is 100% retrievable
5. The Zirconia suprastructure can be segemented into multiple pieces

It provides solutions when the clinician is challenged with non-ideal implant angulations and allows a definitive restoration that satisfies the requirements of fit, esthetics and biomecahincs whilst making the restoration retrievable.

The advantages of this prosthesis are

1. it provides the advantages of the fit of titanium and the esthetics of zirconia
2. The restorations is 100% retrievable
3. It can be CAD designed
4. It can be made in multiple sections so that is a problem should arise the individual section with the problem can be addressed.

About The Authors

Domenico Cascione *obtained his primary education in Bari (Italy), where he was also certified as a Dental Technologist (CDT) in 1985. From 1991 to 2004 he carried out metallurgy research becoming a specialist in dental metallurgy. From 1986 to 2004 he was the owner and director of Dental Laboratory in Bari (Italy). He is a Master Ceramist and also is specialized in metallurgy, implant work and complex esthetic rehabilitation. In 2005 he holds a Bachelor of Science of the Dental Technology degree from the University of Illinois.*

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He currently holds a Faculty position as an Associate Clinical Professor at the University of Southern California (USC) School of Dentistry; he is a Clinical teacher at the Eastman Dental Institute in London and also is on the Board of Directors for the British Academy of Restorative Dentistry. He maintains a private practice limited to Prosthodontics and Implant Dentistry in Oxnard and Woodland Hills, CA.

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Mr. Claudio Tinti *was a certified dental technician in 2001 in Rome, Italy. From 2001-2008 he was manager for the implant department of Made in Italy Dental Laboratory. From 2008-2013 he specialized in complex implant rehabilitation and worked with Mr. Antonello DiFelice, Dr. Gaetaeno Calesini, and Dr. Gianfranco Politano in Rome, Italy. In 2010, Dieter Schulz on "Bussola Di Poltz" trained him for dynamic occlusion. Since 2014, he has been a consultant of Biotech SRL Milling Center Cad/Cam technology related to implant bar design.*