

Implant rehabilitation in the edentulous jaw: the “All-on-4” immediate function concept

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“The All-on-4 technique involves tilting the posterior implants, allowing the clinician to avoid anatomical structures...”

When a patient loses all of their teeth, they are essentially relegated to living the life of a “dental cripple”. Chewing efficiency is lost, their level of comfort declines and often they appear to age prematurely. Edentulism can be a result of poor oral hygiene and dental disease; equally however, there are patients that have heavily restored failing dentitions that have become non-restorable. A growing number of the population possess a terminal dentition and the ability to retreat is restricted due to the poor remaining tooth structure and support, combined with limitations from the financial burden of full mouth reconstruction.

It is well recognized that an edentulous condition has a negative impact on your life. Common complaints with conventional dentures are pain, instability, gagging, lack of retention, diminished oral sensory function and minimal masticatory efficiency. In combination, these complaints impair function as well as lower self-esteem.

In recent times, osseointegrated implant-retained prostheses have allowed many patients to improve their quality of life when compared to complete



Figure 1. Radiograph of All-on-4 treatment concept, with axial implants in the anterior region and tilted posterior implants. Patient has an all-acrylic provisional prosthesis.

dentures. This has traditionally been with a conventional loading protocol whereby implants are placed and allowed to osseointegrate undisturbed and then loaded at three months or more with a definitive prosthesis. This has been a very predictable and successful procedure transforming countless patient lives and ensuring a better quality of life.



Figure 2. Edentulous maxilla.



Figure 3. All-on-4 guide (Nobel Biocare) placed in the midline and the band contour parallels to lower arch.

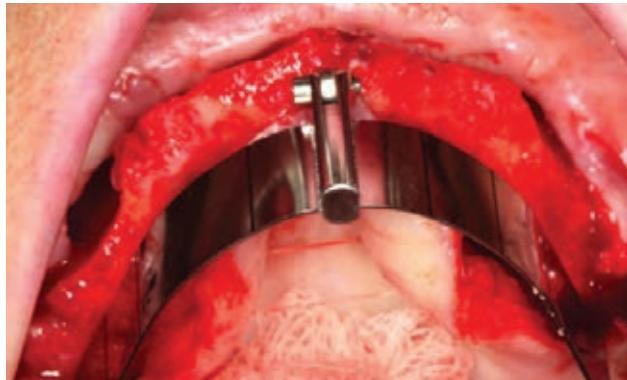


Figure 4. All-on-4 guide (Nobel Biocare).



Figure 5. Maxillary antrum located so that posterior implant is angulated anterior to wall of sinus, allowing a longer implant length as well as placement into better quality bone anteriorly. The more posteriorly located implant also allows a reduction of cantilever posteriorly.

Treatment concept

The “All-on-4” treatment concept was developed by Paulo Malo and encompasses an immediately loaded full arch fixed prosthesis anchored with four implants in either the maxilla or mandible. Utilising immediate function full arch prostheses in the maxilla and mandible has been documented as a predictable and successful procedure based on long-term results.

After teeth have been removed in the completely edentulous jaw, there is often significant bone loss due to resorption resulting in minimal bone volume, poorer bone quality and the need for bone grafting to be carried out prior to implants.

The “All-on-4” concept utilises:

- Two axially orientated implants in the anterior region; and
- Two tilted posterior implants (Figure 1).

Dental implants traditionally have been placed axially, along the long axis of the desired tooth to accept forces axially down the implant. In the completely edentulous jaw, there is often insufficient vertical height after bony resorption in the posterior regions. This may be due to bone resorption after teeth removal and the proximity of the inferior dental nerve in the lower jaw and the maxillary sinus in the upper jaw. Historically, there would be a need for bone grafting to augment the posterior regions to build vertical height for adequate implant length, adding significant time, morbidity and cost to the procedures. In the maxilla, sinus augmentation with a lateral window approach is necessary with an extended treatment

time of up to 5 months. In the mandible, bone augmentation with onlay grafts or nerve transposition could be carried out to allow placement of implants posteriorly. Other alternatives to overcome

Table 1. Advantages of the All-on-4 concept

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|--|
| • Angled posterior implants avoid anatomical structures |
| • Angled posterior implants allow longer implants anchored in better quality bone |
| • Reduces posterior cantilever |
| • Eliminates bone grafts in the edentulous maxilla and mandible in majority of cases |
| • High success rates |
| • Implants well-spaced, good biomechanics, easier to clean |
| • Immediate function and aesthetics |
| • Final restoration can be fixed or removable |
| • Reduced cost due to less number of implants and avoidance of grafting in the majority of cases |

limitation in bone quantity have been the use of long distal cantilevers, short implants or implants placed into the zygoma or pterygoid plate. These procedures have their own advantages, risks and complications and require significant expertise for predictable success.

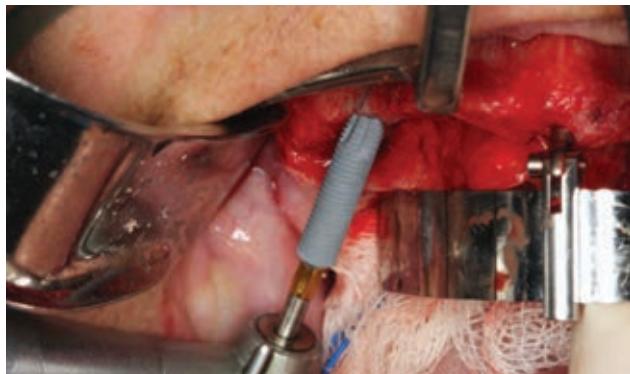


Figure 6. Nobel Speedy Implant (Nobel Biocare) being inserted.



Figure 7. Implants placed with straight multi-unit abutments on anterior implants and 30 degree angulated abutments posteriorly.



Figure 8. Open tray impression made with wire and GC resin splinting for improved accuracy.

The All-on-4 technique involves tilting the posterior implants, allowing the clinician to avoid anatomical structures. It also enables the placement of longer implants into better quality bone anteriorly. When used in the mandible, tilting of the posterior implants makes it possible to achieve good bone anchorage without interfering with the mental foramina. In severely resorbed maxillae, the tilted implants are an alternative to sinus floor augmentation.

Biomechanical measurements show that, when part of a prosthetic support, tilted implants do not have a negative effect on the load distribution.¹ The tilted distal implants results in a better spread of the implants along the alveolar crest which is beneficial for the load distribution and allows the final prostheses to hold



Figure 9. All acrylic provisional prostheses on temporary cylinders.

as many as 12 teeth with only short cantilevers. Cantilevers in prosthodontics can produce significant biomechanical stress to implants and the minimization of these is recommended to reduce prosthodontic complications. Additionally, the tilting of implants also allows an increased inter-implant space allowing easier oral hygiene procedures.

Published data on the All-on-4 concept shows a cumulative survival rate of between 92.2 and 100%.²⁻⁷ There is also no difference reported in the marginal bone loss between tilted and axially placed implants, suggesting that angulating implants causes no deleterious effects to the osseointegration process.⁸

Inclusion criteria

All-on-4 can be considered as a treatment option for patients who meet the following criteria:

- Good general health and acceptable oral hygiene;
- Sufficient bone for 4 implants of at least 10mm in length; and
- Implants attain sufficient stability for immediate function.

Examination

Extra-oral examination

- Smile line: examination should reveal if they have a high or low smile line. This will determine whether the transition zone between the junction of the soft tissues and bridge may be seen;
- Lip support and length: patients should be assessed to see if they require a flange for lip support. Removing the dentures or flange from a denture will allow assessment as to whether a flange is required to provide support for proper lip contour; and
- Vertical dimension of occlusion: this will determine the lower facial third height.

Intra-oral examination

- Thickness of mucosa and keratinization of tissues;
- Interarch relationship: bone resorption occurs so that the ridge is located palatally in the maxilla and more buccally in the mandible which often leads to a Class III relationship for fully edentulous patients;
- Interarch space: sufficient distance is necessary to allow placement of the various components for implant rehabilitation;
- Incisal edge position: most aesthetically driven patients require 2-3mm of incisal display at repose position; and
- Signs of parafunction or dental disease.

Radiographic examination

A cone beam computed tomographic scan should be taken to assess the bone volume present. The prognosis is good for placement of implants when the bone profile measures greater than 5mm in width and more than 10mm in vertical bone height.

Surgical protocol

Local anesthetic infiltration injections are given to the patient in combination with sedation if required. Antibiotic prophylaxis and preoperative anti-inflammatories are prescribed for the patient and continued after the procedure as prescribed. Additionally, the patient is instructed in oral hygiene practices including the use of a chlorhexidine mouthwash during the healing process.

The occlusal vertical dimension (OVD) is measured by making two marks on the face (chin and nose) to measure the height, which is maintained during the bite registration process. If there are any modifications required to the OVD, then this should be registered in the new bite registration.

Full thickness flaps are made with crestal incisions to expose the bony ridge and any teeth requiring removal can be extracted. If required, an alveolectomy is carried out with bone rongeurs or burs to level the ridge, remove any extraction sockets and if required to move the transition zone (junction between final bridge and tissues) to be hidden under the lip line. This is often necessary to allow an aesthetic replacement with pink acrylic or porcelain. If the patient has a high smile line, it can be a difficult surgical technique to place implants and contour the soft tissues to have an aesthetic emergence.



Figure 10. Final impressions after integration is verified, being splinted with GC resin and metal.



Figure 12. Individual crowns being designed on zirconia framework.

Implants in the maxilla are placed with two distal implants in the posterior region which are tilted anterior to the maxillary antrum (Figure 5), while in the mandible implants are positioned anterior to the mental foramen. They should be inserted at an angulation of 30-45 degrees. The use of the All-on-4 surgical guide assists in ensuring the placement of the implants with correct positioning, angulation and emergence. The guide is placed into a 2mm osteotomy that is made in the midline position of the maxilla or mandible and the Titanium band is contoured to follow the arc of the opposing arch (Figures 2-3). The guide also assists in retracting the tongue in mandibular cases. The vertical lines on the guide are used as a reference for drilling at the correct angulation, which should not be greater than 45 degrees.

Drilling protocols are followed using the manufacturer's guidelines. The use of an implant with an appropriate design and osseointegrative surface is important to ensure that sufficient primary stability is attained for immediate function. Sites are underprepared to allow maximum bony support for immediate function. A manual torque wrench is used to check the final torque. Final torque should attain 35Ncm to allow immediate function.

Straight, 17° multiunit abutments and 30° angulated abutments with different collar heights are placed onto the implants (Figure 7). These are used to achieve the correct access allowing relative parallelism and so that the rigid prosthesis can be seated passively.

If there are any exposed threads or extraction sockets, or other localized defects, bone grafts are used to augment these areas and the tissues are carefully repositioned and sutured to form a tight seal around the abutments.

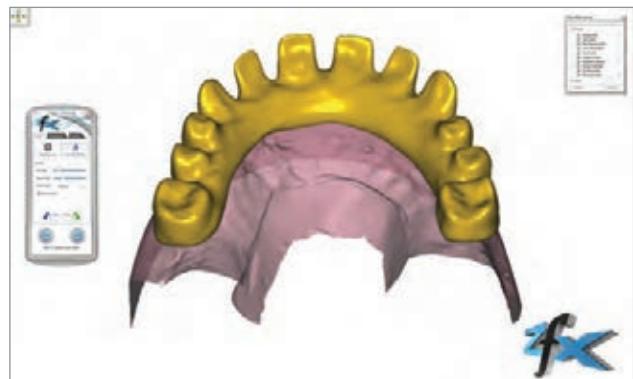


Figure 11. All ceramic Zirconia bridge being designed with CAD/CAM technology (Zfx dental).



Figure 13. CAD/CAM zirconia bridge (Zfx dental).



Figure 14. Individual lithium disilicate crowns in blue phase (e.max, Ivoclar Vivadent).



Figure 15. Individual e.max crowns cutback for layering technique.



Figure 16. Veneering porcelain being applied (e.max ceram, Ivoclar Vivadent).



Figure 17. Crowns luted to zirconia framework.



Figure 18. Final prosthesis ready for insertion.



Figure 19. Implant-supported zirconia bridge framework with individual crowns luted.

Prosthetic protocol

Open tray multi-unit impression copings are placed onto the multi-unit abutments, which are then splinted with a low shrinkage autopolymerising resin (GC pattern resin) and wire bars. This ensures an accurate transfer without accidental displacement of the impression copings. An open tray impression is made with a rigid polyvinyl siloxane material (3M ESPE Imprint Putty) to capture the positions of the implants and the soft tissues.

A provisional all-acrylic resin prosthesis is then constructed and issued to the patient within a few hours or overnight (Figure 9). The provisional prosthesis has shortened cantilevers to minimize overload and also minimize the possibility of acrylic fracture

during the osseointegration period. Occlusion should be carefully adjusted so that there are contacts only in the inter-canine region and no premature contacts posteriorly.^{2,3} Canine guidance is prescribed for lateral excursive movement with no other lateral interferences. The provisional prosthesis is torqued to 15Ncm. The patient is issued instructions for oral hygiene instruction with chlorhexidine mouthwash and a soft diet recommended over the next six weeks. The patient is reviewed after 1 week, at 3 weeks, 3 months and then annually.

At the 3 month appointment, fabrication of the definitive bridge may be started.



Figure 20. Lateral view of smile with final bridge in situ demonstrating lifelike translucency and aesthetics.



Figure 21. Failing upper dentition with very poor prognosis due to periodontal and biomechanical risk factors.



Figure 22. Titanium framework milled for crown cementation.



Figure 23. Opaquer being applied to metal framework.

The final restorative solution can be a:

1. CAD/CAM designed fixed prosthesis with Zirconia (Figures 1-20) or Titanium (Figures 21-25) framework. Individual crowns are cemented to the final bridge framework.
2. Fixed prosthesis with CAD/CAM designed Titanium or Zirconia framework with acrylic veneering (Figures 26-30).
3. Fixed prosthesis with cast metal and veneering porcelain.
4. Removable final prosthesis: e.g. milled bar overdenture, MK1 attachment overdenture (Figures 31-35).

As part of the informed consent process, the relative advantages and disadvantages of either a fixed or removable solution should be discussed with the patient. The main benefit of a removable solution is that it allows simpler hygiene practices, which may be beneficial for the elderly patient. A removable solution may also be necessary for patients requesting more lip support, as the flange on a removable solution may assist in supporting the contours of the face. The use of a flange necessitates a removable solution for hygiene.

Discussion

The All-on-4 concept is a highly successful treatment option for the edentulous patient with excellent clinical outcomes. This is achieved without major grafting and its associated costs and surgical morbidity. The reduced number of implants and componenrty also enables a reduction of cost compared to traditional

implant reconstructions. The All-on-4 concept is a paradigm shift in how implants are placed and angulated compared to traditional concepts with axial placement in a vertical manner. The angulations allow placement that avoids anatomical structures and also allows the use of longer implants, enabling increased bone to implant contact and placement of the implant into better quality bone anteriorly.

A concern raised by some clinicians is the possibility of failure of one implant and the subsequent inability to support a fixed prosthesis, as this requires a minimum of four implants. The success of implant therapy suggests that failure occurs very seldom, however if an implant does fail, all is not lost. Late implant failures are not common so if there has been an early failure the provisional prosthesis can be modified and the implant can be replaced and utilized within the same prosthesis and then the final prosthesis can be constructed once integration has been verified.

The long term results of this technique and numerous advantages of immediate loading, the reduced morbidity, the high patient satisfaction and the relatively low costs should be taken into account when a decision among the alternative treatment options for an edentulous jaw has to be made.

Acknowledgements

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Figure 24. Individual lithium disilicate (e.max) crowns in blue phase prior to sintering trialled on framework.



Figure 25. Intra-oral view of titanium bridge framework with individual lithium disilicate (e.max) crowns.



Figure 26. Failing upper teeth due to extensive periodontal disease with severe mobility.



Figure 27. Final titanium bridge with wrap-around acrylic resin.



Figure 28. Final titanium bridge with wrap-around acrylic resin. Note the smooth tissue fitting contour for easier maintenance.



Figure 29. Final acrylic wrap-around titanium bridge framework with acrylic resin teeth.

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Figure 30. Final smile of patient with acrylic wrap-around titanium bridge.



Figure 31. Failing dentition with both upper and lower teeth with hopeless prognosis due to advanced periodontal disease.



Figure 32. Mandibular All-on-4 with MK1 attachment on implant bar.



Figure 33. Removable prosthesis with locking pins (MK1 attachment).



Figure 34. Note the locking pin mechanism of the MK1 attachment that allows the patient to remove the prosthesis for cleaning when engaged.



Figure 35. Removable implant overdenture in the mandible.

About the author

Dr Ho achieved his Bachelors degree in dentistry with First Class Honours at the University of Sydney. He has completed postgraduate studies in the Graduate Diploma in Clinical Dentistry in Oral Implants at the University of Sydney and a Masters of Clinical Dentistry in Prosthodontics with Distinction from King's College, London. Dr Ho lectures extensively on aesthetic and implant dentistry and is involved with the evaluation and development of new dental products and

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