



Tilted Implants: A Review

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Abstract

Rehabilitation of patients with completely edentulous maxilla and mandible with implant becomes difficult because of less bone quantity, poor bone quality, maxillary sinus in posterior maxilla and mental foramen and mandibular canal in mandible. Sinus lifting procedure and bone augmentation procedure were required to treat such patients, prior to implant placement. This article reviews on an alternative treatment procedure in which two posterior implants are placed at an angle eliminating the need for sinus lift or bone augmentation procedures.

Keywords: Tilted Implants; Angled Implants; All on Four Implants; Angulated Implants; Non Axial Implants; Co- Axis Implants

Introduction

Replacement of lost teeth with dental implants has been used for replacing missing teeth for more than 50 years and considered as a viable treatment modality to replace missing teeth. Dental Implants were first introduced by "Per-Ingvar Branemark" where he observed that human body would not only tolerate titanium but also integrate into living bone tissues [1].

Patients with severe bone resorption require prior bone augmentation and sinus lift procedures for its successful outcome. Several treatment modalities were identified for the fixed rehabilitation of the edentulous maxilla and mandible, they are rehabilitation with and without bone augmentation procedures, and sinus floor elevation with interposition bone grafts, nerve repositioning, various grafting procedures, distraction osteogenesis, ridge splitting etc. These procedures not only lengthened treatment time, but also increased patient morbidity during implant rehabilitation cases [2].

Regular, tilted, and zygoma implants are treatment modalities that do not require bone augmentation or other surgical treatment modalities [3].

Angled Implants were first introduced in the early 1990's. Implants were originally tilted in a bodily fashion to bypass certain anatomical structures that otherwise hindered clinicians from placing them in areas such as the maxillary sinus, inferior alveolar nerve canal, the mental foramen, mandibular lingual concavities and maxillary buccal concavities [4].

In addition to bypassing the anatomical constraints, the tilting of posterior implants in a distal manner results in an increase in the length of the prosthetic table thereby allowing better load distribution and reducing the cantilever lengths [4].

Tilted implants feature 12°, 24° or 36° correction angles which allow for implant placement into existing native bone without time consuming and painful bone grafting augmentation procedures [4].

While using tilted implants along with the angulated abutments the fixture platform emerges in an optimal esthetic angle and relatively parallel to other implants in the arch thereby allowing the fabrication of screw retained full arch restorations. Subsequently the use of cements and costly angled abutments is eliminated [5].

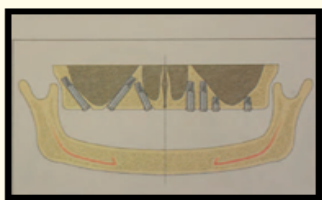


Figure 1: Tilting of implants in early 1990.

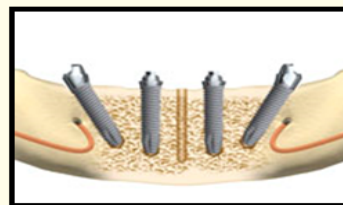


Figure 3: Tilted implants.

History of implants

In 1913 Greenfield's implant, an iridioplatinum implant attached to a gold crown, showed evidence of osseointegration [6]. (Figure 2)

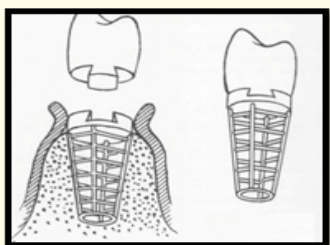


Figure 2: Greenfield crib.

In 1940 Bothe, Beaton and Davenport used titanium and observed that how bone grew surrounding titanium screw and is very difficult to remove them [7].

In 1951, Gottlieb Leventhal used titanium rods in rabbits which led him to conclusion that titanium is the ideal metal for surgery [8].

In 1965 Branemark placed titanium dental implant into a human. He termed "osseointegration" the adherence of bone with titanium.

In 1990 Angled Implants were first introduced in which zygomatic implants and pterygoid implants are included [4].

The concept "All on four" initially proposed in 2003 study as a treatment plan for edentulous mandible.

Need for Tilted implants

Tilted implants were useful in the treatment of edentulous jaws avoiding the bone augmentation procedures and the involvement of anatomical structures during surgery. However, tilting of distal implants in full-arch rehabilitation allows to reduce cantilever length and to augment the antero-posterior distance between the most anterior implant emergence and the most posterior ones with several prosthetic advantages [10].

Surgical complications during implant placement in posterior region such as bone resorption, poor bone quality, jaw shape, location of mental foramen or loop of alveolar nerve, presence of sinus, mandibular nerve and canal associated with maxilla and mandible can be taken care of [11].

Rationale of tilted implants

1. To achieve primary implant stability (35 to 45 Ncm insertion torque) [12].
2. Indicated with a minimum bone width of 5mm and minimum bone height of 10mm from canine to canine in maxilla and 8mm in mandible.
3. If angulation is 30° or more, the tilted implants can be splinted.
4. For tilted posterior implants, the distal screw access holes should be located at the occlusal face of the first molar, the second premolar, or the first premolar.
5. Improved masticatory functions in terms of chewing efficiency and bite force [12].

Advantages of tilting implants:

1. Stability in minimum bone volume: Longer implants can be used in minimum bone volume with advantage of in creasing bone-to-implant contact and reducing the need for vertical bone augmentation.
2. Clinical results are better.
3. Need for bone grafting is eliminated.
4. Can be performed in patients with systemic diseases which are contraindicated for bone grafting.
5. The angulations allow avoids impingement of anatomical structures.
6. Biomechanical advantage in using tilted distal implants rather than distal cantilever units.
7. Reduce the length of cantilevers without performing bone grafting or sinus lifting.

8. Alternative to maxillary sinus floor augmentation procedures.
9. Distally tilted implants induced better loading transmission than vertical implants [13].

Disadvantages of tilted implants

1. Technique sensitive procedure.
2. Surgeon need to be very skillful.
3. Computer guided surgical stent required for implant to be placed in desired angulation.
4. Not even slight change in angulation can be done.
5. Long term studies are not available [13].

Tilted vs non tilted implants [11]

Tilted implants	Non tilted implants
Anatomical structures can be bypassed by tilting implants. For example: Maxillary sinus can be bypassed by tilting implant at an angle.	Anatomical structures should be taken care while placing parallel implants. For example: Maxillary sinus, mental foramen, mandibular canal.
Cantilever length may be reduced resulting in better load distribution.	Cantilever length is not reduced hence less stress distribution
Tilted implants enable immediate loading and fabrication of implant supported restorations	Immediate loading is not possible.
Longer implants can be used	Implants size will be selected while taking vital structures into consideration.
Zygomatic bone and pterygoid bone can be engaged thus providing better anchorage and primary stability.	Zygomatic bone and pterygoid bone cannot be engaged
Eliminates bone augmenting procedures, bone grafting and sinus lifting.	Bone augmenting procedures, bone grafting and sinus lifting may be necessary in some cases

Table 1

Implant design

This tapered body tilted implant is available in 12°, 24° and 36° degree built in angle, ranging in 4,5, 6 mm diameter and 8.5mm to 18mm in length. It is currently available in the external hex, Trihex and internal octagon connections. In extreme cases for even higher angle correction, the Co-Axis implant can be combined with a 17° or even the 30° angled abutment.

The angled direction indicator inserted into the osteotomy site and the axis is checked regarding the access hole position for screw retention as well as for parallelism with other implant fixtures. (Figure 4)

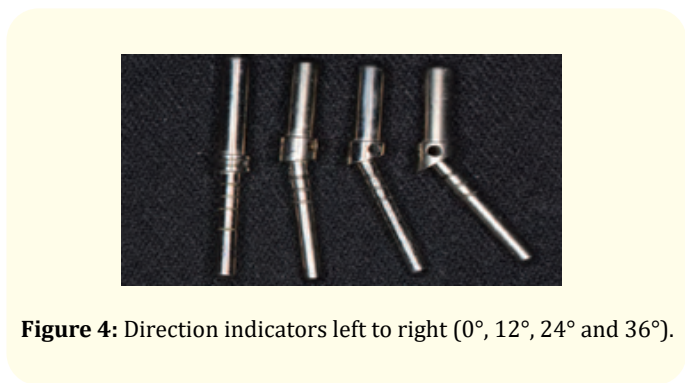


Figure 4: Direction indicators left to right (0°, 12°, 24° and 36°).

Based on the tooth and cephalometric analysis, the angulated implant was designed as follows

1. 5mm restorative interface.
2. 12° angulation from long axis (Figure 5 (a) and (b)).
3. Reduced pitch of thread which allows 0.5mm apical movement per placement rotation. This ensures that placement depth is controlled by less than 0.5 mm.
4. Implant length will range from 10 mm-18 mm.
5. Taper ranges from 8.2° (10 mm implant) to 3.6° (18mm implant). This allows for a total angulation discrepancy from available buccal maxillary cortex to screw access ranges from 30° (10 mm) to 25.6° (18 mm).
6. Placement is affected by means of a angular corrected fixture mount marked to assist with correct orientation [14].

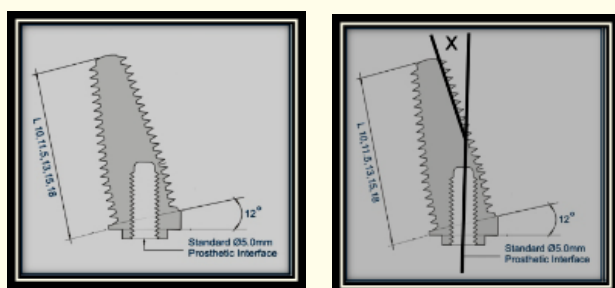


Figure 5(a) and 5(b)

The all on four concepts

The All on four treatment concepts was developed to provide edentulous patient with an efficient and effective restoration using only four implants to support an immediately loaded full arch prosthesis [15].

Tilting two posterior implants enhances bone to implant contact by providing optimum bone support even with minimum bone volume. Tilting of implants in maxilla allows for improved anchorage in better quality anterior bone and biocritical anchorage in the cortical bone of the sinus wall and nasal fossa [15].

A completely edentulous jaw is often characterized by resorption related minimization of bone volume and a reduction in bone quality.

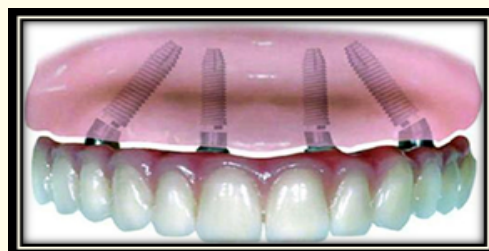


Figure 6

These features may necessitate bone grafting before implants are placed. Bone augmentation techniques such as sinus augmentation with a lateral window approach (in the maxilla) and only grafts or nerve transposition (in the mandible) are traditional approaches, however they add significant costs and lengthen the duration of treatment [16].

Other alternatives such as the use of long distal cantilevers, short implants, or implants placed into the zygoma or pterygoid plate offer advantages but require significant expertise for predictable success [16].

Principle of all on four

Four implants – two straight implants in the anterior and two angled implants in the posterior supporting of provisional, fixed, and immediately loaded full arch prosthesis [15].

Zygomatic implants

Zygomatic implants, first introduced by Branemark in 1988, are especially suitable for patients with advanced atrophy of the maxilla and who refuse or have suffered a complication after bone grafting procedures. These implants had a palatal emergence, which crosses the maxillary sinus and were anchored in the zygomatic bone. By “extra maxillary” implants technique, the palatal emergence can be avoided where the zygomatic implant goes through the lateral wall of the maxillary sinus [16].

Pterygoid implants

The rear area of the maxillary bone has many limitations for the placement of dental implants, such as poor bone quality and quantity (usually a Class III or IV according to Lekholm and Zarb). The presence of the maxillary sinus, accessibility problems, and the difficult hygiene they entail.

In addition to these anatomic peculiarities and difficult access, there is high occlusal loading in the molar regions in comparison with other areas, resulting in a lower success rate than elsewhere in the maxillary or the mandible [17].

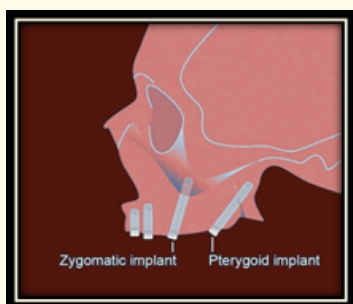


Figure 7

These implants have advantages over other techniques: They allow anchorage in the posterior atrophied/resorbed maxilla without sinus lifts or bone grafts, achieving stability and high rates of long-term success. In addition, posterior cantilevers can be eliminated, and axial loading is improved.

Indications

In the edentulous upper jaw, the placement of implants can be difficult due to limited bone and presence of the maxillary sinus. Pterygoid implants have high success rates, bone loss levels are same as conventional implants, minimal complications and acceptable by patients.

However, pterygoid implants have mainly been studied in partial edentulism as an alternative to sinus lift procedures

Conclusion

Tilted implants are a treatment solution for patients with edentulism and is associated with predictable outcomes. The placement and angulation of implants in the All-on-4 concept is unique as compared with the axial placement in a vertical manner.

In addition to bypass anatomical structures, these angulations allow the use of longer implants which increases bone-to-implant contact. This biomechanical advantage reduces posterior cantilevers and allows for well-spaced implants.

Reductions in the number of implants and components needed further augment the cost-effectiveness of this concept compared with traditional implant reconstructions.

However, failures of implants with this technique are relatively less, and early failures can be resolved by modifying the provisional prosthesis and the implant can be replaced and used within the same prosthesis. After this, the final prosthesis can be constructed after the verification of optimal integration. In patients with greater risk factors, the placement of additional 5 implants in the mandible or 6 implants in the maxilla can be considered.

The long-term efficacy of the All-on-4 technique and its numerous advantages, such as immediate function and esthetics, reduced morbidity, high patient satisfaction, and relatively lower costs, should be considered when assessing treatment options for an edentulous jaw.

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