



## TILTED IMPLANTS: WHEN, WHERE AND HOW?

### Prosthodontics

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### ABSTRACT

In rehabilitation of atrophic ridges present in edentulous patients, implants with length > 10 mm in posterior regions of the jaw poses challenges to the operator like bone of poor quality, deficient bone, proximity to mandibular canal, sinus in case of maxilla. The complex surgical procedures have been advocated by different authors such as bone augmentation and sinus lifts have their own drawbacks. The use of tilted implants in resorbed ridges as a treatment modality resulted in increase of bone-implant contact, and with increased inter implant distance resulted in better load distribution.

### KEYWORDS

Tilted implants, Atrophic ridge, All-on-4 concept, Bone augmentation, Sinus lift

### INTRODUCTION:

In natural dentition the surrounding alveolar bone along with the periodontal ligament are the supporting structures for the tooth. The fiber of the periodontal ligament helps in maintaining position of the tooth in their sockets. The various forces applied on the tooth resulted in different types of resultant forces which are generated within the periodontal ligament such as the vertically applied forces resulted in generation of tensile forces between the alveolar bone and periodontal ligament and further resulted in stretching of the ligament whereas the forces applied in angled position on the natural tooth resulted in mixed reaction i.e. generation of both compressive and tensile forces in different regions of the periodontal ligament.<sup>1</sup>

The implants in alveolar bone are supported due to enveloping of the mineralized bone on implant surface.<sup>2</sup> However at certain points the fibrous connective tissue contacts with surface of an implant, but calcified material constitutes the major portion of the implant bone interface.<sup>4</sup> The implants in similarity to the tooth are subjected to various complex forces in the oral cavity. The modifications made in the structure of implants with resemblance to screw pattern macrostructure and complicated microscopic features resembling patterns of spikes along with surface treatment results in generation of complex forces even greater than those in case with natural dentition.<sup>5</sup>

In natural dentition aim should be focused on centering all applied forces down along the long axis of tooth whereas achieving similar pattern in case of dental implants is not of much importance as the mixture of complex forces like tensile, compressive and shear forces act microscopically along with the different threads of the microstructure of implant. Previously the implants were suggested to be placed in a manner to cater the axial load similar to that of natural dentition but recently newer concept have developed by various clinicians to place implants with minor angulations or tilt which resulted in off-axis implant loading of implants and such implants were not found to be failed with progression of time.<sup>4</sup>

The rehabilitation of patients with resorbed ridges using endosseous implants with implant length more than 10 mm in posterior areas often accompanied with challenges such as low quality of bone, proximity to mandibular canal, alveolar nerve loop along mental foramen and sinus proximity in case of maxilla.<sup>6,7,8</sup>

In previous times, rehabilitation of edentulous maxilla or mandible were based upon classical Branemark system concept of implants were placed in upright positioning for fabrication of cantilever bilaterally with molar extension up to 20 mm for enhancing the chewing efficiency of the patient resulted in the increased chances of implant failure.<sup>9,10,11</sup>

The different treatment modalities followed for countering the anatomic challenges in resorbed ridges includes use of short implants,

reconstruction option such as bone grafting, sinus elevation in maxilla and other modalities such as use of zygomatic and pterygomaxillary implant placement.<sup>12,13,14</sup>

These other alternative techniques utilized for treatment of edentulous resorbed ridges resulted in limitations such as morbidity at bone graft sites, uncertain predictability of results, patient discomfort, and other complications of the complex surgical procedures.<sup>15,16,17</sup>

Tilted implant as choice of treatment modality in case of resorbed posterior alveolar ridges can be placed parallel to sinus anterior wall in case of maxilla or mental-foramen in case of mandible.<sup>18,19</sup> Tilted implants when used along with abutments situated at an angle resulted in achieving better esthetics and parallelism to other implants for assembling restorations retained with screws, which eliminates requirement of costly dental cements and other abutments.<sup>20</sup>

### Historical Background:

1. Greenfield's implants (1913), an iridio-platinum implant were used for attachment of gold crown, revealed prolonged osseointegration.<sup>21</sup>
2. Bothe, Beaton and (1940) Davenport suggested that use of titanium as implant material resulted in growth of bone surrounding the titanium screw and this union is further difficult to separate.<sup>22</sup>
3. Branemark (1965) first placed the titanium implant into human jaw and coined the term "osseointegration" as adhesion of titanium with bone.<sup>23</sup>
4. Graves SL (1994) suggested the pterygoid plate implant as a measure to rehabilitate the posterior maxilla.<sup>24</sup>
5. Paulo Malo (2003) introduced concept of All-on-4 as 'immediate-function' with Implant Branemark system for rehabilitation of edentulous mandible.<sup>25</sup>

### Why tilted implants are need?

The restoration of the edentulous spans in maxilla is accompanied with challenges like sufficient residual bone is present in anterior-region, whereas there is marked bone resorption in posterior region following extraction of teeth.<sup>26</sup> Maxillary sinus and limited bone in this posterior maxillary region are prime limitations for an implantologist.<sup>27</sup> The surgical procedures like sinus augmentation had been advocates for implant placement by different authors, but at times these procedures may be associated with post-operative complications like sinusitis, donor site morbidity, bleeding for the operating site, graft loss along with implant, fistulae and osteomyelitis.<sup>28</sup> Whereas in case of resorbed mandible alveolar nerve might be present superficially and its violation during implant placement might result in nerve injury.<sup>29</sup>

The tilting of implants in case of atrophic mandible results in prevention of injury to mandibular nerve. In edentulous maxilla tilting

of implants in posterior region can be adopted as an alternative procedure to sinus augmentation and allowing support of more cortical bone to tilted implant for enhancing the primary stability of implant, along with increasing inter-implant gap and reducing span of cantilever for better distribution of load resulting in implant success.<sup>30,31</sup>

**Tilted implant rationale:**

1. The increased length of tilted implants resulted in increase of implant-bone contact which further leads to achievement of greater primary stability (35 to 45 Ncm of insertion torque).<sup>32</sup>
2. Presence of large sinuses in maxilla requires placement of tilted implants parallel to anterior sinus wall inclined distally.<sup>33</sup>
3. In case of mandible if mental foramen are located farther from the crest of bone the greater the inclination of tilted implant can be achieved, resulting in implant platform to be located more distally thus elimination longer cantilevers.<sup>19</sup>
4. Tilted implant in posterior region should be placed such that distal screw access holes appear along occlusal aspect of 1<sup>st</sup> molar and 2<sup>nd</sup> or 1<sup>st</sup> premolar region.<sup>34</sup>
5. The tilted implants resulted in increased inter implant distance and better distribution of occlusal load therefore resulting in improved masticatory efficiency as biting forces are enhanced.<sup>32</sup>

**Advantages of using tilted implants:<sup>35</sup>**

1. Enhanced implant stability in atrophic ridges: The longer tilted implants when placed in atrophic ridges with minimum bone resulted in increase of implant-bone contact and eliminating use of bone augmentation procedures.
2. The post operative results obtained with tilted implants are better in case of atrophic ridges.
3. The anatomic structure which poses as challenges to the operator like sinus and nerve can be avoided with utilization of tilted implants as treatment modality.
4. Tilted implants can be inserted safely in patients with other systemic conditions in whom complicated surgical procedures like sinus lift, bone augmentation cannot be carried out.
5. The use of distally tilted implants eliminates the longer cantilevers as the inter implant distance is increased which results in success of the prosthesis and prevention of implant failures.
6. The excessive costly procedures like bone grafting and sinus lift surgical procedures can be avoided if the tilted implants are opted as the treatment modality in atrophic ridges.

**Limitations of using tilted implants:<sup>35</sup>**

1. The insertion of tilted-implants in resorbed ridges is technique sensitive procedure.
2. The insertion of tilted-implants should be incorporated with application of computer guided template for locating proper angulations of these implants.
3. Minor changes in angulations of these tilted implants can lead to implant failure.
4. Prolonged recall studies have not been established for determining success of tilted implants.

**Description of implant design:**

The tilted implants are available in tapered body configurations with inbuilt of different angulations of 12°, 24° and 36 degree, diameter in range of 4 to 6 mm and lengths varying from 8.5mm to 18mm. The presently available connections include internal hex, internal octagon and tri hex connections. In cases where higher angulations are required for correction the Co Axis implants in combination with abutments with 30° tilt can be utilized.<sup>34</sup>

**Comparisons of tilted and non-tilted implants are shown in following (table1.):**

| Tilted implants   | Non-tilted implants   |
|---|---|
| 1. The vital anatomical structures appearing with in the implant operating field can be avoided using tilted implants | 1. Non-tilted implants should be inserted such that the vital anatomical structures in operating field can be prevented from damage |
| 2. Implants with longer length can be used  | 2. The selection of length of non-tilted implants depends upon the height of available bone   |

|   |  |
|---|--|
| 3. The longer cantilevers can be avoided by increasing the inter implant distance resulting in enhancement of support to prosthesis | 3. The length of cantilever cannot be reduced and resulted in poor load distribution   |
| 4. Immediate loading can be performed in case of tilted implants and prosthesis can be fabricated                                   | 4. The loading of non-tilted implants in atrophic ridges is not feasible   |
| 5. Tilted implants can obtain their support from zygomatic and pterygoid bone for enhancement of primary stability                  | 5. The non-tilted implants cant engage the zygomatic and pterygoid bone  |
| 6. Costly complex surgical techniques like augmentation of bone and sinus elevation can be avoided                                  | 6. The complex surgical techniques such as sinus elevation and augmentation of bone are mandatory for placing non-tilted implants in atrophic ridges |

All on four concept: This All on four concept was first introduced for providing completely edentulous patients with restorations which were efficient enough to be supported by only 4-implants supporting prostheses for full arch, immediately loaded after placement of implants.<sup>36</sup> In this All-on-4 concept of treatment tilting of two implants placed distally was done to enhance implant-bone contact area therefore obtaining greater bone support for the implant. The angulations of tilted implants in case of maxillary arch are as such adjusted so as to provide enhanced anchorage in anterior region and bicortical anchorage in the sinus anterior wall and nasal fossa for achieving primary stability of the implants.<sup>34</sup>

**Zygomatic implants:**

These implants were introduced first by Branemark (1998), as desirable option of treatment for highly atrophic maxillary ridges where bone grafting had been attempted and implants had failed previously. The zygomatic implants are placed palatally to cross sinus and obtain anchorage from the zygomatic bone. The extra maxillary approach modality can prevent the palatal emergence of these zygomatic implants if they are inserted via lateral wall of sinus for obtaining enhanced support of surrounding bone.<sup>37</sup>

**Pterygoid implants:**

These implants are used in maxilla where atrophic ridge and poor quality of alveolar bone are present as shortcomings for placement of regular implants. The different challenges such as large maxillary sinus, difficult approach and greater load in the maxillary molar region, results in implant failure as compared to the other regions of the maxillary and mandibular arches.<sup>25</sup>

**CONCLUSION:**

The rationales of utilizing tilted implants are based upon biomechanical principles of elimination of length of cantilevers due to increase of inter implant distance resulted in better distribution of load induced by the over lying prosthesis. The tilting of implants can augment anterior-posterior spread of implants on resorbed ridge enhancing polygonal-area which would furnish enough support in molar-region for complete fixed- prosthesis. The future studies should be performed on this topic for assessing long term success of tilted-implants for supporting fixed-prosthesis in edentulous patients.

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