Inclusion Criteria

a) Search Criteria

MATERIALS AND METHODS

Implant'.

articles using terms 'Angulated implant', 'offset implant' and 'tilted implant'.

fabricated on angulated implants over a period of 1-10 y. Literature review was performed in Pub Med Central, EBSCOHOST, scholarly

of implants placed according to this concept and prosthesis

The aim of this review article was to evaluate the success rate

ridges.

implants for rehabilitation of patients with severely resorbed alveolar

time but there is no consensus about the routine use of angulated

Since then, several clinicians and researchers have reported use of

angulated implants with varying degrees of success over a period of

Advantages of Tilting implants

1. Stability even in minimum bone volume: Longer implants can be used in minimum bone volume with advantage of increasing bone-to-implant contact and reducing the need for vertical bone augmentation.

2. Good clinical results.

3. Eliminates the need for bone grafting which is invasive with unpredictable outcome [3].

4. Can usually be performed in patients with various systemic conditions which are often contraindications for bone grafting [3].

5. The angulations allow placement that avoids anatomical structures [1].

6. There is a biomechanical advantage in using tilted distal implants rather than distal cantilever units [4].

7. Reduce the length of cantilevers without performing bone grafting or sinus lifting [5].

8. Effective and safe alternative to maxillary sinus floor augmentation procedures [6] and to pneumatised maxillary sinus [7].

9. Distally tilted implants induced better loading transmission than vertical implants [8].

• The search was limited to studies involving human subjects.

• Restrictions were not placed regarding the study design and the language usage.

• A minimum follow-up duration of one year was selected.

• All original research articles, review articles, case reports, case series and pilot studies were included.

• Immediate as well as delayed implant placement cases were included.

Exclusion Criteria

• Studies conducted in animals.

b) Search strategy

A literature review was performed in Pubmed Central, scholarly articles, EBSCO host, google etc. Keywords such as “dental implant,” “tilted implant,” “angled implant,” “angulated implant,” “offset implant,” “upright implant,” “axial implant,” “edentulous patient,” “edentulous mandible,” “edentulous maxilla,” and “all on four” were used alone or in combination.

ADVANTAGES OF TILTING IMPLANTS

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Various studies are available regarding success rate of angulated implants and prosthesis survival.

Success rates in the maxilla at five years were 98% for tilted implants and 93% for non-tilted implants.

There were no implant failures in mandible while cumulative success rates in the maxilla at five years were 98% for tilted implants and 93% for non-tilted implants.

Implant bone Interface

Cehreli et al., [24] demonstrated in their in-vitro study that angulated implants were associated with higher forces acting on the implant-bone interface during axial loading of maxillary or mandibular superstructures that were supported by four implants.

Particularly high loads acting on the implant-bone interface must be expected in single tooth restorations, and these loads will become more severe with increasing length of the load arm involved (off-axis loading) [25].

Kvanc and Halun [26] performed spiral CT study to evaluate effect of residual bone angulation on implant supported fixed prostheses in 30 patients and found minimum angulation values at second premolar, first and second molar region were 0°, 3°, and 9° respectively. Average values being 4°, 10°, 15° and maximum values 11°, 18°, 22° respectively.

Bone loss around an implant placed at an angle is same or less as compared to that around axial implant [10,14,19].
• No correlation exists between implant angulation and bone loss [27,28].

(c) Implant Angulation:
• Angled implants have smaller quantity of fringes and stresses which were located mostly around apical region of lateral implants [29].
• Gulizio et al., [30] studied an effect of implant angulation on retention of overdenture attachment and concluded that angle had an effect upon retention of gold matrices, but not for titanium matrices.
• Pellizzer et al., [31] studied influence of implant angulation with different crowns on stress distribution and found that screwed prosthesion exhibited highest stress concentration. Higher the implant angulation, higher is the stress value, independent of crown type.
• Increasing the tilt of distal implant does not increase the stress significantly. Architecture of mandible plays a major role during treatment planning of complete edentulous patients [32].

DISCUSSION
The present review discusses an alternative mode of treatment in cases where there is too much of bone resorption which limits implant treatment. To avoid various invasive procedures like bone augmentation and sinus lift, this modality is gaining popularity amongst patients and surgeons. Various short term studies are supporting this procedure strongly in terms of success rate. Axial implant placement has been accepted worldwide as a successful treatment modality for prosthetic rehabilitation. When various criteria for success of implant prostheses were established, crestal bone loss around implant neck, longevity or survival of the restoration etc. are considered along with complications associated with implants; most of the studies have demonstrated excellent success rate over a period of time (1-10 y) with an average of more than 95%. Commonly accepted criteria for assessment of implant success were proposed by Albrektsson et al., [33] Misch et al., [34] at the International Congress of Oral Implantologists (ICOI) pisa consensus conference. Based on above criteria, number of studies has been reported claiming success rate of the order of 78-100% with more than 15 y of observation time [35-37].

In case of atrophic maxilla, implant placement isn’t possible without undergoing invasive procedures like bone augmentation or sinus lift procedure or both. Several types of complications may occur during and after the sinus elevation procedure like Schneiderian membrane perforation, nose bleeding, post operative pain and swelling even though it was not described an important negative effect on implant success rates [38]. But patient may be under psychological stress and addition of burden of an extra surgery and increased cost if enough bone isn’t available to carry out sinus lift and implant placement at same appointment [39].

Bone grafting, though practicable now a days is dependent on many factors like type of bone graft used (autogenous, alloplastic or xenograft), host response, age of patient, various complications associated with grafting procedure, infection and most importantly time spent while graft material matures and is taken up by bone. One review revealed that there are not many studies providing data on success rate of dental implants placed in onlay graft augmentedridges and demonstrated, on average, a poor methodological quality [40]. Considering all these things, placement of an angled implant avoiding both invasive procedures like sinus lift and bone augmentation procedure is a viable treatment option [41]. Bone tolerates the forces more favourable when those are directed vertically. Forces on axial implants are directed vertically along long axis of an implant and suggested to be more favourably as they distribute stress more evenly throughout implant [42]. This explains high survival or success rate of axially placed implants with a minimum crestal bone loss of 0-0.2mm/year [43-45]. But scenario is different in case of angled implants. The angled implants direct the forces at an angle and thus are associated with higher forces acting on implant bone interface during axial loading [24] which should logically induce bone resorption by disrupting bone implant interface which is supported by in vitro experiments that show that non axial loads cause stress concentration in the marginal area of bone [38-41] but this hasn’t been demonstrated in vivo or in other words crestal bone around neck of an implant but this doesn’t happen because all prostheses fabricated on implants placed using this technique are removable type and produces intermittent type of force on implants in contrary to fixed prostheses. But, one study has showed excellent outcome with immediately loaded fixed full prosthesis [19]. Also, it has been proved that tilting of posterior implants improves prosthetic support [22].

Various studies carried out regarding success rate of angled implants have shown same or less amount of crestal bone loss in comparison to axial implants [10,14,19]. Some studies have advocated that we should not place single angled implant to replace single missing tooth since prosthesis fabricated over it will be of fixed type creating more amount and duration of load and increased off axis loading [25]. In one meta analysis, author found no difference in success rate between tilted and axial implant [23]. This opens our thought process that tilted implants can be placed at high success rate as that of axial implant. In various studies surgeons used four implants to replace complete maxillary or mandibular denture of which two were placed at an angle and two axially. None of the researchers have used or advocated the use of all four angulated implants since load distribution will not be favourable in such case. It seems that in their opinion, placement of two axial implants is essential when two angled implants are used in order to distribute load more favourably. In addition, most of the studies are short term ranging from 1-3 y. Though short term studies show no difference in amount of bone loss around axial and angulated implant, data available is not sufficient to predict long term success.

Vertical forces applied during mastication and deglutition is supposed to cause more bone destruction than horizontal forces acting around an angled implant. Also, stress values are directly proportional to implant angulation. Deflection and stress concentration generally increases with increase in either magnitude or angle of loading. When vertical loads are applied to vertical and angled implants, there is only apical migration in vertical implants but there is significant deflection coupled with some apical migration in angled implants [46]. Duration of force applied is more influential in bone resorption and deformation than is the amount of force [47]. Therefore, long term clinical and histopathological studies are necessary and recommended to utilise this modality in routine practise. However, this procedure is a viable concept in short and medium term [13-15,17].

CONCLUSION
This technique is extremely technique sensitive, useful in patients with resorbed ridges but long term studies are required to evaluate its success rate in terms of load distribution, marginal bone loss around implant and prosthesis survival but currently many practitioners are treating patients with this modality with a great success.

REFERENCES


