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Update on short, angulated and diameter-reduced implants

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1. Methods

1.1 Objective

The purpose of these guidelines is to offer recommendations for clinicians engaging in implant dentistry, enabling them to correctly assess potential indications (and any limitations thereof) for short, angulated or diameter-reduced implants.

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1.2 Introduction

This consensus paper covers only titanium implants typically placed in accordance with the indications recommended by the European Consensus Conference (EuCC, Germany, 6 February 2016).
All consensus recommendations in this paper should be considered as guidelines only. The patient's specific situation is always an important consideration and may justify a deviation from the recommendations of this consensus paper.

1.3 Background

Avoiding bone augmentation through reduced--dimension implants and optimum utilization of available bone volume is often recommended being a minimally invasive treatment option [45].To ensure an acceptable treatment outcome, dimension and insertion type must be considered in addition to the number of implants.

1.4 Literature search

The Cochrane Library, EMBASE, DIMDI and Medline literature databases were used to conduct a systematic search of recently published data on the use of short, angled or diameter-reduced implants. Selective search criteria were used, including terms such as "short implants", "angulated implants", "angled implants", "tilted implants", "outcome grafting procedure", and "implant -failure". The publications identified by the search were screened by reading their abstracts, and those irrelevant to the subject were identified and excluded. Publications found to be potentially relevant were obtained in full-text form. Multiple review papers with meta-analyses and randomized controlled trials (RCTs), and other prospective and retrospective systematic clinical studies were available on the subject.

1.5 Procedure for developing the Consensus Conference guidelines

A preliminary version of this document on which the EuCC based its deliberations was prepared by *Dr J. Neugebauer* of the Interdisciplinary Policlinic for Oral Surgery and Implantology and Department of Oral and Maxillofacial Plastic Surgery at the University of Cologne/Germany. The preliminary report was then reviewed and discussed by the sitting committee members in five steps as follows:

- Reviewing the preliminary draft
- Collecting alternative proposals
- Voting on recommendations and levels of recommendation
- Discussing non-consensual issues
- Final voting

The full text of all (potentially) relevant citations was obtained if necessary and reviewed. Numerous reviews, but few RCTs (randomised controlled trials) or other systematic clinical trials are available on this topic.

2. Problem

The application of standard implants in patients with atrophy of their alveolar ridges or large pneumatization of the maxillary sinus cavity often requires the use of hard tissue augmentation procedures [18, 17]. These procedures are established, and widely used with success. But depending on level of training of the user and the patient-specific risk factors, complications may occur and affect the postoperative quality of life [1, 9, 19, 18, 17, 33].

3. Use of short implants

3.1 Introduction

Short implants are increasingly being discussed as a treatment alternative in situations characterized by limited vertical bone height [3].
Compared to the use of standard implants due to biomechanical considerations (e.g. crown-to--implant ratio, C/R) with short implants may lead to unfavourable loading conditions and complications, including excessive crestal bone loss and implant failure [23]. Improvements in implant design and surface along with the use of modified implant insertion methods all are intended to minimize these risks [14].

3.2 Definition of short implants

Implants are usually referred to as short if their designed intrabony length measures ≤ 8 mm with diameters ≥ 3.75 mm. Standard implants are considered to be those with lengths > 8 mm and diameters ≥ 3.75 mm [43, 47]. “Ultra-short” implants are considered to be those with lengths less than 6 mm [13].

3.3 Indications for short implants

Short implants are primarily used to avoid bone augmentation procedures in the maxillary and mandibular posterior segments of partially edentulous patients. They are applicable if vertical bone volume is limited by anatomical structures (maxillary sinus, mandibular canal), but there is sufficient alveolar ridge width to permit successful use of implant diameters ≥ 3.75 mm. They are also used to support removable overdentures as single or multiple tooth replacements in the anterior jaws [47, 48].

3.4 Current observations

For ultra-short implants, there is insufficient evidence to make recommendations at this time. A review paper from 2015 summarized findings with RCTs on sinus floor elevation with standard length implants or short implants on their own. Five studies reported 16–18 months survival rates for long implants in combination with sinus elevation of 99.5 % (95 % CI: 97.6 – 99.98 %) and for short implants alone of 99.0 % (95 % CI: 96.4 – 99.8 %). For shorter observation periods of 8 – 9 months in three studies, survival rates for long implants were 100 % (95% CI: 97.1 – 100 %) and for short implants alone 98.2 % (95 % CI: 93.9 – 99.7 %) [53]. These results are supported by other RCTs [49, 52].

The number of RCTs on the use in the mandible is limited [42]. In these RCTs, no relevant differences in biological parameters between the use of short and long implants in the posterior mandible were found [20, 27]. One group has presented five-year results showing no significant difference for the application of short implants alone as compared to standard implants and vertical augmentation in the mandible [21].

A retrospective comparative analysis also showed no differences between short and long implants for an observation period of five years [24]. Meta-analysis showed high survival rates for short implants with moderately rough surfaces [37]. Long-term data for observation periods of 10 years for the posterior mandible of partially edentulous patients and 20 years for mandibular overdentures showed favourable results for short, sintered porous-surfaced implants [15, 16].

The literature does show, however, that short implants with a reduced diameter have failure rates of up to 10 % after three to five years [11].

3.5 Prevention of complications

Some authors have offered recommendations on how to avoid complications that are mainly biomechanical in nature. These recommendations include:

- Machine-surfaced, short implants should not be used [37]
- Short implants should only be used if bone -quality is favourable [48]
- Restoration with single crowns [2, 28, 38, 53]
- Primary splinting of threaded short implants [39]
- Guiding surfaces for lateral movements should be avoided [10]
- Insertion at or below bone level with tapered abutment design [30, 34]
- The implant surgeon and restorative dentist should have adequate training [53]
- For short implants no data available for immediate loading procedures

4. Use of angulated implants

4.1 Introduction

Angulated standard implant designs or non-angulated ones placed in off-axis (tilted) positions are increasingly being used for the splinted reconstructions of edentulous jaws, again as an alternative treatment option to avoid hard tissue augmentation procedures, but also to increase primary stability for immediate loading procedures with longer implants [10]. The objective of having implants in a tilted position is to utilize as much bone as possible, while still avoiding vital adjacent structures (e.g. the mental foramen in the mandible or the maxillary sinus in the maxilla). They also increase the surface area for restorative support (through diverging implant axes) [4]. Restorations can be inserted on these implants via angulated abutments.

4.2 Current observations

Studies of immediate loading concepts with angulated implants used to support full-arch reconstructions on four or six implants in the maxilla and mandible have provided five-to-ten-year data [6, 7, 22, 26, 32, 35]. Favourable survival rates were found following the use of primary splinting of angulated/tilted implants with fixed dental prostheses (FDP) for follow-up intervals of up to 6.5 years [36]. Various meta-analyses show no differences compared to conventional implant placement/loading in either survival rates or crestal bone loss in the restoration of atrophied edentulous jaws with FDP and angulated implants after a short and medium observation time [5, 10, 12, 40].

4.3 Restoration-related experiences

Using a cantilevered, shortened dental arch with a lack of posterior support resulted in no increased prevalence of oro-mandibular malfunctions [46].

4.4 Prevention of complications

- Placement of angulated and immediately restored implants should be effected with sufficient primary stability (and splinted with immediate restoration)
- For anatomically and prosthetically correct angulated implant placement, a pre-operative 3D computer-based diagnosis is recommended
- The implant surgeon and restorative dentist must have adequate training

5. Use of diameter-reduced implants

5.1 Definition

Diameter-reduced implants (DRIs) can be defined as those with intraosseous diameters below 3.5 mm for placement in sites with reduced alveolar ridge bone width [47]. Implants with diameters less than 2.7 mm are referred to as mini-implants [25, 50].

5.2 Current observations

Diameter-reduced implants generally have high survival rates (> 90 %), assuming careful patient selection, assessment of bone density, the clinical approach and the experience of the user [29, 31, 47, 51]. DRIs are also applicable in the posterior region with high success rates [31].

Many retrospective studies are available for mini-implants. However, meta-analyses with prospective and/or randomized trials show only short-term results and/or increased failure rates [8, 31, 44]. Furthermore, in a recent literature review, it was determined that short mini-implants (≤ 13 mm) will be lost more frequently under load than longer ones (> 13 mm) [51].

5.3 Prevention of complications

- Mini-implants have an increased risk of implant loss
- Short mini-implants should be avoided [54]

6. Recommendations for short, angulated or diameter-reduced implants

Provided the specific treatment parameters are observed, the use of short, angulated or diameter-reduced implants in sites with reduced bone volume can be a reliable treatment option, given the risks associated with the use of standard-dimension implants in combination with augmentation procedures. The implant surgeon and the restorative dentist must have appropriate training to choose the best possible therapy for each patient [41].

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