Bundesverband der implantologisch tätigen Zahnärzte in Europa

European Association of Dental Implantologists

Guidelines

Short and Angulated Implants (Development Stage: S2[1])

By the 6th European Consensus Conference (EuCC) on 5 March 2011 in Cologne

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1. Methods

Objective
The purpose of this guide is to offer recommendations for clinicians engaging in implant dentistry, enabling them to correctly assess potential indications (and any limitations thereof) for short or angulated implants.

Background
Prevalence of the clinical problem, therapeutic uncertainty, avoidance of complications.

Literature search
The Cochrane Library, EMBASE, DIMDI and Medline literature databases were used to conduct the search. Selected search criteria were used, including terms such as *short implants*, *angulated implants*, *stress analysis*, *biomechanics,* and *implant failure*. The studies returned by the search were screened by reading the abstracts. Studies found to be irrelevant to the subject were identified and excluded on this basis. All articles that were found to be (potentially) relevant were obtained in full-text form. No randomized controlled trials or other systematic clinical studies were available on the subject.

Procedure for developing the guide/consensus conference
A preliminary version on which the EuCC based its deliberation was prepared and authored by PD Dr H.J. Nickenig and Professor J.E. Zöller of the Interdisciplinary Policlinic for Oral Surgery and Implantology and Department of Oral and Maxillofacial Plastic Surgery at the University of Cologne/Germany. The consensus conference was organized in five steps:

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

[1] Development stage S2 = a formal process of consensus finding or a formal review of evidence has taken place.

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2. Use of short implants

2.1 Introduction

Short implants are increasingly being discussed as a treatment alternative in situations characterized by limited vertical bone height, considering the extensive requirements of surgical and reconstructive implant treatment. Based on biomechanical considerations (e.g. the crown-implant ratio), less than favourable loading conditions must be expected to act on the implant and implant bed with short implants than with standard implants. Advanced implant features (design and surface) and the use of specific treatment options are believed to minimize the risk of treatment.
No randomized controlled trials were available at the time of the consensus conference. The studies that were available for review were mainly retrospective studies (evidence levels IIb/III), so the level of recommendation of these Guidelines falls into class B (indicating "should"-type recommendations).
This guide refers only to short implants for prosthetic loading.

2.1 Definition of short, medium and long implants

Implants are usually referred to as short if their length measures less than 8mm. Medium implants are 9–13 mm in length, and long implants are usually understood to be over 13 mm in length (Olate et al., 2010, review). By comparison, the cut off for distinguishing between narrow and wide implants is approximately 4 mm.

2.2 Indications for short implants

Short implants are primarily used in the maxillary and mandibular posterior segments if the vertical bone volume is reduced with still a sufficient width of bone and limited by anatomical structures (maxillary sinus, mandibular canal). They are placed as an alternative to conducting procedures of bone augmentation (Romeo et al., 2010; Renouard and Nisand, 2006).

2.3 Survival rates and experience

The findings of this retrospective study are based on observation periods ranging from 2 up to a maximum of 5 years on average (Anitua et al., 2008; Anitua et al., 2010; Arlin, 2006; Corrente et al., 2009; Li et al., 2010; Malo et al., 2006; Misch et al., 2006; Morand and Irinakis, 2007). Most of the more recent studies involve favourable survival rates ranging from 95% to 99%. Somewhat less favourable values (94 to 96% after 2 years) have been reported for the posterior maxilla (Renouard and Nisand, 2005). It has been indicated that implants with reduced length *and* diameter should be expected to carry an increased rate of implant loss, reaching up to 10% after 3–5 years (Das Neves et al., 2006).
Generally the level of evidence is rather low yet.
For instance in a comparative study, 15 patients showing 5–6 mm of subantral bone volume and 15 patients showing 5–6 mm of bone volume above the mandibular canal were evaluated. Short implants were used in the study group, while the control group involved standard implants in conjunction with bone augmentation. Minor clinical differences were observed with regard to complications in the healing phase and in the early phase of prosthetic service. The patients felt that both procedures were acceptable (Felice et al., 2009).
No randomized controlled trials or other systematic clinical studies were available on the subject.

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2.4 Avoiding complications

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

- Machined short implants should not be used (Renouard et al., 2006; Das Neves et al., 2006; Olate et al., 2010).
- Short implants should only be used if bone quality is favourable (Renouard and Nisand, 2006; Romeo et al., 2010).
- Primary splinting of short implants (Misch et al., 2006).
- Cantilever pontics should be avoided (Misch et al., 2006).
- Guiding surfaces for lateral movements should be avoided (Misch, 2005; Romeo et al., 2010).
- Short implants should not be used in patients with parafunctional habits (Romeo et al., 2010).
- The implant surgeon and restorative dentist should have adequate clinical experience (Misch et al., 2006; Romeo et al., 2010).

2.5 Recommendations for the inclusion of short implants

For the time being, the benefit-to-risk ratio of short implants (less than 8 mm in length) cannot be clearly assessed in terms of suitability for practical use (evidence level III is offered by the currently available studies). No randomized controlled trials or other systematic clinical studies were available on this subject. The process of selecting appropriate patients for such treatment should therefore include a critical appraisal of treatment alternatives (bone augmentation plus medium or long implants). Crestal bone loss potentially influences the survival rate of short implants more than on long implants.

Any inclusion of short implants should be consistent with a well-proven surgical and implant-restorative treatment concepts (also see 2.4 „Avoiding complications“). Long-term postoperative care is essential with special emphasis on prevention of crestal bone loss. The length of implants has an influence on the crown-implant-ratio and has to be considered in implant restorative treatment concepts.

The implant surgeon and restorative dentist must have adequate training and clinical experience.

3. Use of angulated implants

3.1 Introduction

Angulated implants, too, are increasingly being discussed as an alternative treatment option in situations of limited vertical bone height, considering the extensive requirements of surgical and reconstructive implant treatment. The objective of placing implants in a tilted fashion is to utilize as much bone as possible, bypassing endangered adjacent structures (e.g. the mental foramen in the mandible or the maxillary sinus in the maxilla), and to increase the surface area for restorative support (through diverging implant axes). Restorations can be inserted on these implants via angulated abutments.

At the time of the consensus conference, few randomized controlled trials and other systemic clinical studies were available on the subject (evidence levels IIb/III); the search was therefore extended to include the results of basic research and in-vitro studies.

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3.2 Bone-related experience

Cehreli et al., 2002 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.

Finite-element analysis has led to the conclusion that the degree of loading to which the bone is subjected by angulated implants will depend on bone quality, with load levels becoming progressively smaller as the amount of cortical bone anchorage increases.

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) (O'Mahony et al., 2009, finite-element study).

All-on-four concepts evaluated by photoelastic analysis revealed that only small differences in the forces acting on the implant-bone interface should be expected with implants exhibiting inclinations of 15°–30° and with primary splinting. Force levels should be expected to increase disproportionately with more heavily inclined (> 40°) implants (Begg et al., 2009). Peak loads will occur in the apical implant segment, followed by the crestal segment, while force levels will be lowest in the central implant segment.

Reports on the immediate loading of angulated implants have existed for 5–10 years in the context of all-on-four concepts used in the maxilla/mandible (Ferreira et al., 2010; Maló et al., 2003). Favourable survival outcomes are available for all-on-four concepts in conjunction with primary splinting via all-in-one bridges; however, no results have yet been reported based on follow-up intervals exceeding 2–5 years (Maló et al., 2007).

3.3 Restoration-related experience

Numerous studies have been published on problems related to the accuracy of transferring impressions (Conrad et al., 2007, in vitro). Special impression techniques, such as the use of custom transfer abutments, have been reported.

Pampel et al. (2006) and Assuncao et al. (2004) concluded from their in-vitro studies that the accuracy of impressions becomes increasingly less favourable in the presence of greater angulations between implants.

Other problems related to implant prosthetic concepts concern the loss of retention of the superstructures involved (ball attachments are particularly affected), which will depend on the degree of abutment divergence. Significant loss of retention should be expected even at a divergence of 20°–30°, while smaller differences of up to 10° will have negligible effects (Gulizio et al., 2005, in vitro).

One-piece solid abutments are to be recommended if angulated designs are used (Lin et al., 2008).

Walton et al., 2001, reported in an in-vitro-study that angular divergences between implants do not play a major role if confined to a single three-dimensional plane (e.g. the frontal plane or the sagittal plane), while significantly more prosthetic complications can be expected, if angular deviations are also present in a different plane (e.g. lateral, ventral, dorsal).

3.4 Recommendations

- The use of angulated implants should remain confined to situations of favourable bone quality (preferably greater than D3).
- Angulated implants should only be placed after suitable 3D-planning, leading to 3D-treatment guidance.
- Greater inclinations of the implants lead to increased force levels at the implant-bone and implant-abutment-interfaces. Therefore extreme angulations should be avoided.
- Inter-implant angulations should be confined to a single three-dimensional plane to simplify prosthetic restoration.

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- Single-tooth restorations and cantilever bridges on angulated implants should be avoided, and the aim should be to splint the implants.
- The implant surgeon and restorative dentist must have adequate training and clinical experience.

4. References

4.1 Short implants

Arlin ML. Short dental implants as a treatment option: results from an observational study in a single private practice. Int J Oral Maxillofac Implants 2006;21(5):769-76.

Anitua E, Orive G. Short implants in maxillae and mandibles: a retrospective study with 1 to 8 years of follow-up. J Periodontol 2010;81(6):819-26

Anitua E, Orive G, Aguirre JJ, Andia I. Five-year clinical evaluation of short dental implants placed in posterior areas: a retrospective study. J Periodontol 2008 Jan;79(1):42-8.

Corrente G, Abundo R, des Ambrois AB, Savio L, Perelli M. Short porous implants in the posterior maxilla: a 3-year report of a prospective study. Int J Periodontics Restorative Dent 2009;29(1):23-

Cozzolino A, Balleri P, Ruggiero G, Veltri M. Use of short implants for functional restoration of the mandible after giant cell tumor removal. Case report. Minerva Stomatol 2006;55(5):307-14.

Das Neves FD, Fones D, Bernardes SR, do Prado CJ, Neto AJ. Short implants-an analysis of longitudinal studies. Int J Oral Maxillofac Implants 2006;21(1):86-93.

Li R, Sun W, Shi B. Retrospective analysis of placing short dental implants in the posterior areas. Zhonghua Kou Qiang Yi Xue Za Zhi 2010;45(12):708-711.

Malo P, de Araujo Nobre M, Rangert B. Short implants placed one-stage in maxillae and mandibles: a retrospective clinical study with 1 to 9 years of follow-up. Clin Implant Dent Relat Res 2007;9(1):15-21.

Misch CE. Short dental implants: a literature review and rationale for use. Dent Today 2005;24(8):64-6, 68

Misch CE, Steignga J, Barboza E, Misch-Dietsh F, Cianciola LJ, Kazor C. Short dental implants in posterior partial edentulism: a multicenter retrospective 6-year case series study. J Periodontol 2006;77(8):1340-7.

Morand M, Irinakis T. The challenge of implant therapy in the posterior maxilla: providing a rationale for the use of short implants. J Oral Implantol 2007;33(5):257-66.

Olate S, Lyrio MC, de Moraes M, Mazzonetto R, Moreira RW. Influence of diameter and length of implant on early dental implant failure. J Oral Maxillofac Surg 2010 Feb;68(2):414-9.

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Renouard F, Nisand D. Short implants in the severely resorbed maxilla: a 2-year retrospective clinical study. Clin Implant Dent Relat Res 2005;7 Suppl 1:S104-10.

Renouard F, Nisand D. Impact of implant length and diameter on survival rates. Clin Oral Implants Res 2006;17 Suppl 2:35-51

Romeo E, Bivio A, Mosca D, Scanferla M, Ghisolfi M, Storelli S. The use of short dental implants in clinical practice: literature review. Minerva Stomatol 2010;59(1-2):23-31

4.2 Angulated implants

Assuncao WG, Filho HG, Zaniquelli O. Evaluation of transfer impressions for osseointegrated implants at various angulations. Implant Dent 2004;13(4):358-66.

Begg T, Geerts GA, Gryzagoridis J. Stress patterns around distal angled implants in the all-on-four concept configuration. Int J Oral Maxillofac Implants 2009;24(4):663-71.

Cehreli MC, Iplikcioglu H, Bilir OG. The influence of the location of load transfer on strains around implants supporting four unit cement-retained fixed prostheses: in vitro evaluation of axial versus off-set loading. J Oral Rehabil 2002;29(4):394-400.

Conrad HJ, Pesun IJ, De Long R, Hodges JS. Accuracy of two impression techniques with angulated implants. J Prosthet Dent 2007;97(6):349-56.

Cooper LF, Rahman A, Moriarty J, Chaffee N, Sacco D. Immediate mandibular rehabilitation with endosseous implants: simultaneous extraction, implant placement, and loading. Int J Oral Maxillofac Implants 2002;17(4):517-25.

Engquist B, Astrand P, Anzen B, Dahlgren S, Engquist E, Feldmann H, Karlsson U, Nord PG, Sahlholm S,
Svardstrom P. Simplified methods of implant treatment in the edentulous lower jaw. A controlled prospective study. Part I: one-stage versus two-stage surgery. Clin Implant Dent Relat Res 2002;4(2):93-103

Felice P, Checci V, Pistilli R, Scarano A, Pellegrino G, Esposito M. Bone augmentation versus 5-mm dental implants in posterior atrophic jaws. Four-month post-loading results from a randomised controlled clinical trial. Eur J Oral Implantol 2009;2(4):267-81.

Ferreira EJ, Kuabara MR, Gulinelli JL. "All-on-four" concept and immediate loading for simultaneous rehabilitation of the atrophic maxilla and mandible with conventional and zygomatic implants. Br J Oral Maxillofac Surg 2010;48(3):218-20.

Galan Gil S, Penarrocha Diago M, Balaguer Martinez J, Marti Bowen E. Rehabilitation of severely resorbed maxillae with zygomatic implants: an update. Med Oral Patol Oral Cir Bucal 2007;12(3):E216-20.

Griffitts TM, Collins CP, Collins PC. Mini dental implants: an adjunct for retention, stability, and comfort for the edentulous patient. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2005;100(5):e81-4.

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Gulizio MP, Agar JR, Kelly JR, Taylor TD. Effect of implant angulation upon retention of overdenture attachments. J Prosthodont 2005;14(1):3-11.

Lin CL, Wang JC, Ramp LC, Liu PR. Biomechanical response of implant systems placed in the maxillary posterior region under various conditions of angulation, bone density, and loading. Int J Oral Maxillofac Implants 2008;23(1):57-64.

Malo P, Rangert B, Nobre M. “All-on-Four" immediate-function concept with Branemark System implants for completely edentulous mandibles: a retrospective clinical study. Clin Implant Dent Relat Res 2003;5 Suppl 1:2-9.

Malo P, de Araujo Nobre M, Lopes A. The use of computer-guided flapless implant surgery and four implants placed in immediate function to support a fixed denture: preliminary results after a mean follow-up period of thirteen months. J Prosthet Dent 2007;97(6 Suppl):S26-34.

O'Mahony A, Bowles Q, Woolsey G,Robinson SJ, Spencer P. Stress distribution in the single-unit osseointegrated dental implant: finite element analyses of axial and off-axial loading. Implant Dent 2000;9(3):207-18.

Pampel M, Wolf R, Dietrich S. A prosthodontic technique to improve the simplicity and the efficacy of angled abutments for divergent implant situations: a technical note. Int J Oral Maxillofac Implants 2006;21(2):320-4.

Walton JN, Huizinga SC, Peck CC. Implant angulation: a measurement technique, implant overdenture maintenance, and the influence of surgical experience. Int J Prosthodont 2001;14(6):523-30.

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