Bundesverband der implantologisch tätigen Zahnärzte in Europa e.V.
European Association of Dental Implantologists

Digital workflow in implant dentistry

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Guidelines 2017

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1 Methods

1.1 Objective

The purpose of this guideline is to offer recommendations for clinicians engaging in implant dentistry, enabling them to correctly assess potential indications (and any limitations) for a digital workflow.

1.2 Introduction

This consensus guideline covers the various digital procedures for diagnosis, surgical preparation, digital implant planning and prosthetic rehabilitation typically used in accordance with the indications recommended by the European Consensus Conference on implantology (EuCC, Cologne, Germany, 25 February 2017).

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

Digital procedures to improve or simplify the implant prosthetic workflow are presented for various treatment steps. To ensure an acceptable treatment outcome, the selection of the appropriate digital procedure for each indication is necessary.

1.4 Literature search

The Cochrane Library, EMBASE, DIMDI and Medline literature databases were used to conduct a systematic search of recent published data on digital workflows and directly related topics. Selective search criteria were used, including terms such as *digital, implant, cad/cam, superstructure, surgical guide*. The publications identified by the search were screened by reading their abstracts; those irrelevant to the subject were identified and excluded. Articles found to be potentially relevant were obtained in full-text form. Multiple review papers with meta-analyses and randomized controlled trials (RCTs) as well as other prospective or retrospective systematic clinical studies proved to be available on the subject.

1.5 Procedure for developing the Consensus Conference guidelines

A preliminary version on which the EuCC based its deliberations was prepared and authored by Dr Jörg Neugebauer and Professor Hans-Joachim Nickenig 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

2 Problem

Complex implant/prosthetic treatment can be performed in various stages with the support of digital technology. Today the aim in selected cases has been to improve the treatment efficiency and outcome by using a fully digital workflow[12, 13]. Various concepts are in use, but the innovation cycles and outcomes should be considered for complication-free use in daily practice.

3 Digital diagnosis

3.1 Introduction

Routine implantological diagnosis is still based on panoramic imaging, which has limitations in terms of measurement accuracy and the possibility to determine the available bone supply, especially in the posterior maxilla[10, 32]

3.2 Cone-beam CT

The adjunctive use of 3D-data based on cone-beam technology provides more information to help avoid problems and perform a more detailed diagnosis[7]. Scanning parameters such as voxel size vary depending on the device used and result in discrepancies at the subclinical level, which might influence the subsequent process chain[37].

3.3 Digital design imaging

The use of digital information other than x-ray as a contribution to the overall prosthetic diagnosis based on function and aesthetics.

4 Preparation of allogeneic block grafts and individual implants

4.1 Introduction

To reduce donor site morbidity, various kind of allogeneic or xenogeneic block grafts were presented in the past[18]. There has been controversy regarding the evidence for their outcomes[3, 5]. Alternatively, a titanium mesh is used to stabilize the graft, but this requires an intensive intraoperative adaptation to the defect. Custom dental implants made by copy-milling were first presented more than two decades ago, but have not become established as routine clinical procedures[19, 30].

4.2 Custom-made bone block and implants

To improve outcomes and simplify workflows, the use of CAD/CAM technology and cone-beam volumetric data for custom-made bone blocks, shaping of titanium-meshes and implants is recommended[22].

4.2 Current observations

Clinical studies on improved outcomes are in progress.

5 Surgical guides

5.1 Introduction

Various systems for guided surgery are available, using surgical guides and real-time navigation[6, 15, 25]. The accuracy is higher for surgical guides than for real-time navigation[15]. By using surgical guides, more reproducible and more accurate results can be achieved in comparison to free-hand placement[26, 27].

5.2 Current observations

Discrepancies between planned and actual implant positions can be up to about 1 mm crestally and around 2 mm in the apical region, with an angular deviation of about 5 degrees[6, 36]. These results have been confirmed by RCTs[39]. Surgical guides strictly supported by soft tissue in the edentulous jaw are not inferior[38].
Bone-supported surgical guides exhibit lower accuracy[6].

5.3 Prevention of complications

- Greater deviations for longer implants and shorter sleeves[35].
- Conventional guides or guides based on optical scans are more accurate than guides designed based on CBCT data[31].
- For completely edentulous jaws, fixation with mini-implants or anchor screws increases accuracy[6].
- Case selection for type of guided surgery requires previous experience in conventional procedures in order to be able to switch if required.
- Minimally invasive therapies such as flapless surgery require specific training to achieve an optimal outcome[24, 38].
- Greater deviations may occur in individual operator and patient situations[33].

6 Digital impressions

6.1 Definition

Only controversial data is available regarding what is most precise impression technique for dental implants[28]. Digital impressions are taken as chairside scans to generate the data to fabricate surgical guides, master-casts and implant superstructures.

6.2 Current observations

Clinical data have shown that digital impressions result in an acceptable fit for single-crown and short-span fixed prostheses[2]. Only one RCT showed time efficiencies in vitro for digital impressions of small spans[14].

6.3 Prevention of complications

- Clinical studies on scanning full arches are in progress.
- The transfer of the occlusal situation and the articulation is not established on a routine basis.

7 CAD/CAM abutments

7.1 Definition

Custom CAD/CAM abutments can be produced by chairside procedures with prefabricated inserts or by milling centres on the original or on a copy of the implant interface[16]. No information is available regarding the precision and quality of the two procedures[21].

7.2 Current observations

Custom CAD/CAM abutments offer many options for ideal design in terms of biomechanical and material parameters. The use of custom CAD/CAM abutments does not guarantee that subgingival cement residue is avoided, although a reduction in cement residue has been shown after crown cementation[40].
The use of custom CAD/CAM abutments showed advantages in soft-tissue stability in a multicentre prospective clinical trial after a two-year follow-up[23]. Controversial data indicate no improvement in clinical performance or patient satisfaction compared to the use of stock zirconia abutments[34].
Special emphasis should be placed on the precision of the implant/abutment interface. Initial research in vitro has demonstrated no difference in terms of implant adaptation of stock vs. one-piece CAD/CAM abutments[4].

7.3 Prevention of complications

- Care must still be taken to always carefully remove cement residue after intraoral cementation.
- The use of resin-based luting agents in combination with air-abrasion of titanium inserts and zirconia copings provided stable retention of two-piece CAD/CAM abutments[11].
- Screw-retained crown abutments might be favourable from a biological point of view, with a risk of mechanical complications.

8 CAD/CAM superstructures

8.1 Definition

Various CAD/CAM fabrication procedures such as milling or selective laser melting are available[16, 20]; they require the validation of workflows. Studies on the precision of screw-retained CAD/CAM superstructures showed improved accuracy in comparison to conventional or copy-milled superstructures, with no relevant differences between the materials used[1, 8, 9, 17].

8.2 Current observations

The available data indicate promising results for CAD/CAM-fabricated implant-supported restorations; nonetheless, current evidence is limited due to the quality of available studies and the paucity of data on long-term clinical outcomes of five years or more[29].

8.3 Prevention of complications

- When using CAD/CAM technology it is recommended to follow a validated workflow.
- If one step in the workflow is changed, it is recommended to revalidate the complete workflow.

9 Conclusion

Clinical data supporting the use of surgical guides and CAD/CAM abutments is solid. Data support for a completely digital workflow for all indications in implant treatment is not yet available.

Cologne, 25 February 2017

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