19th European Consensus Conference updates 2017 Guideline

2024 Guideline: The digital workflow in oral implantology

The 19th European Consensus Conference (EuCC) under the auspices of BDIZ EDI has produced the second update of its Guideline on the digital workflow. The new 12-page Guideline is intended as a recommendation for implant dentists to help them assess the indications and limitations of the digital workflow. Statements on artificial intelligence (AI) have been added.

The 19 international experts of the European Consensus Conference, chaired by Prof. Jörg Neugebauer, highlighted the different steps of complex implant-prosthetic treatments that can be carried out with the support of digital technology. They examined the various digital procedures for diagnosis, surgical preparation, digital implant planning and prosthetic rehabilitation. Aspects covered included:

- Digital diagnosis
- Digital impression-taking and imaging
- CAD/CAM-assisted grafting techniques
- Digitally guided implant positioning
- Digital laboratory procedures
- Artificial intelligence (AI) in oral implantology

Conclusions of the EuCC: Digital technologies in implant dentistry are improving, with good clinical results and better patient-related outcomes (PROMs). The specific parameters for each procedure must be taken into account by the clinician.

Ordering the Guideline

The 12-page 2024 Guideline brochure with its comprehensive bibliography can be ordered from the BDIZ EDI online shop, in German or English, at the price of €4.50 (including VAT, plus shipping).

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19th European Consensus Conference (EuCC) 2024 in Cologne

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Content

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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, February 10th, 2024).

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, grafting, guided surgery, abutment, superstructure, surgical guide, printing, AI* 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 Jörg Neugebauer, Steinbeis University, Magdeburg and Interdisciplinary Department 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

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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**[27, 28]**. 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**[21, 62]**. Due to the invasiveness of ionizing radiation, 3D diagnosis should be decided by individual basis**[36]**.

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**[16]**. Various indication for immediate implant placement, control of grafting procedures and anatomical evaluation are proven**[52]**. 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**[69]**. State-of-the-art devices with a low-dose protocol allow implant planning with reduced radiation doses without decreasing the accuracy of guided implant placement**[53]**.

4 Digital impression and imaging

Digital information other than x-ray can contribute to the overall prosthetic diagnosis based on function and aesthetics.

4.1 Definition

Digital impressions are taken as chairside scans to generate the data to fabricate surgical guides, master casts and implant superstructures.

4.2 Current observations

Digital impressions and CAD/CAM procedures save time and provide stable and predictable outcomes**[78]**. There is no difference in terms of clinical outcomes between conventional and digital impressions, even in full-arch cases**[20, 41]**. The accuracy of full-arch scanning by IOS differs based on clinical scenarios such as scanning strategies**[40, 75]**.
Digital scanning was found to be more time-efficient and convenient than conventional impression-taking for implant-supported restorations**[43]**. No significant differences were found in radiographic marginal bone loss between treatments performed with digital scans and conventional impressions**[60]**.
New technologies like spectrophotogrammetry might have a great potential to improve the workflow for full mouth or multiple implants cases**[55]**.

4.3 Prevention of complications

- Precise scanning of full arches requires specific scanning strategies.
- The transfer of the occlusal situation and the articulation is still not established on a routine basis.
- Significant accuracy differences were found between the IOS, which requires individual selection for the various treatment protocols**[75]**.

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5 CAD/CAM-supported grafting techniques

5.1 Introduction

To reduce donor-site morbidity, various kind of allogeneic or xenogeneic block grafts were presented in the past**[32]**. There has been controversy regarding the evidence for their outcomes**[7, 9]**. Alternatively, a titanium mesh is used to stabilize the graft, but this requires intensive intraoperative adaptation to the defect. Custom dental implants made by copy-milling and segmented CBCT data were presented in the past but have not become established as routine clinical procedures**[34, 59, 64]**.

5.2 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 and the shaping of titanium-meshes and implants are recommended**[12, 13, 38, 66]**.
To improve the outcome various techniques of 3D-printed scaffolds with the option of the use of stem-cells or BMP are under scientific evaluation**[10]**.

5.3 Current observations

Reports on the clinical outcomes are still controversial**[19, 33]**.
The exposure rate for CAD/CAM titanium mesh is lower than for conventional shaping, but a high exposure rate of 31% was still observed**[24, 81]**.

5.4 Prevention of complications

- Specific soft-tissue management is necessary for 3D-printed titanium meshes.

6 Digitally driven implant placement

6.1 Introduction

Various systems for guided surgery are available, using static guided surgery and dynamic guided surgery**[15, 48]**. The accuracy of surgical guides shows no significant difference to dynamic guided surgery**[3, 44]**. Moreover, computer-guided surgery can effectuate accurate implant placement and less post-surgical discomfort.**[78]**. By using surgical guides, more reproducible and more accurate results can be achieved in comparison to free-hand placement**[29, 49, 50, 70]**.

6.2 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**[15, 68]**. These results have been confirmed by RCTs**[74]**.

- Surgical guides strictly supported by soft tissue in the edentulous jaw are not inferior**[73]**.
- Bone-supported surgical guides exhibit lower accuracy**[15]**.
- No difference was observed for GS or FH in respect of MBL changes**[76, 79]**.

Flap and flapless approaches provided similar implant survival rates, but the flap technique provided a slightly better MBL than the flapless approach**[72]**.
Further evidence regarding more clinically relevant outcomes of efficacy (implant survival and success, prosthetically and biologically correct positioning), long-term prognosis and cost is currently scarce**[63]**.
Flapless procedures show less buccal bone resorption in immediate-implant cases**[42, 54]**.

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New technologies with augmented reality-supported navigation could provide better accuracy than conventional navigation and free-hand procedures**[76, 79]**.

6.3 Prevention of complications

- There are greater deviations with longer implants and shorter sleeves**[67]**.
- Conventional guides or guides based on optical scans are more accurate than guides designed based on CBCT data**[61]**.
- For completely edentulous jaws, fixation with mini-implants or anchor screws increases accuracy**[15]**.
- Keyless systems seem to offer greater precision than key systems**[23]**
- 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**[46, 73]**.
- Greater deviations may occur in individual operator and patient situations, depending on the fixation and the type of edentulism**[11, 23, 57]**.
- Learning curve for guided surgery should be done with simple cases.

7 Digital lab procedures

7.1 Digital printing

7.1.1 Introduction

Various printing techniques are available for manufacturing surgical implant guides, implant analogue models, metallic primary frameworks, secondary ceramic or polymer superstructures**[56]**.

7.1.2 Current observations

For clinically acceptable accuracy of implant analogue casts, various technical parameters must be considered**[26]**. Depending on the printer technology, accuracy may change under light exposure**[80]**.

7.2 CAD/CAM abutments

7.2.1 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**[30]**. No information is available regarding the precision and quality of the two procedures**[37]**. Pre-milled interface show higher accuracy than individual processed designs**[4]**

7.2.2 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**[77]**.
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**[39]**. Controversial data indicate no improvement in clinical performance or patient satisfaction compared to the use of stock zirconia abutments**[58, 65]**.
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**[8]**

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7.2.3 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**[22]**.
- Screw-retained crown abutments might be favourable from a biological point of view, with a risk of mechanical complications.

7.3 CAD/CAM superstructures

7.3.1 Definition

Various CAD/CAM fabrication procedures such as milling or selective laser melting are available**[30, 35]**; 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, 17, 18, 31]**.
The marginal fit of implant-supported frameworks manufactured by AM or SM methods is in the clinically acceptable range**[47, 71]**.

7.3.2 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**[25, 51]**.

7.3.3 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.
- Due to the flexibility of the mandible, non-precious metal frameworks should be used for full-arch reconstruction. For ceramic veneering high elasticity alloy should be used.

8 AI in implant dentistry

8.1 Introduction

A growing number of studies employ deep learning in implant dentistry, mainly in digital imaging with radiographs**[6]**. AI models using panoramic and periapical radiographs can accurately identify and categorize dental implant systems or detect changes in marginal bone levels**[5, 14]**. Segmentation procedures of anatomical structures are improved by AI support**[2]**.

8.2 Current observations

New algorithms may determine critical structures like the IAN canal and the available bone for AI implant planning**[6]**. The benefits compared with conventional approaches is not proven**[45]**.

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9 Conclusion

Digital technologies are improving in implant dentistry with good clinical outcomes and improvements in PROMs. Specific parameters for individual workflows must be considered by the healthcare provider.

Cologne, 10 February 2024

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10 Literature

The literature list can be obtained from the following website:
www.bdizedi.org/en/professionals

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