

# Consensus Statements and Recommended Clinical Procedures Regarding Restorative Materials and Techniques for Implant Dentistry

Daniel Wismeijer, Prof Dr, PhD, DDS<sup>1</sup>/Urs Brägger, Prof Dr Med Dent<sup>2</sup>/  
 Christopher Evans, BSc Hons (Qld), MDSc (Melb), MRACDS (Pros)<sup>3</sup>/Theodoros Kapos, DMD, MMSc<sup>4</sup>/  
 J. Robert Kelly, Prof Dr, DDS, PhD<sup>5</sup>/Christopher Millen, BDS, MFDS, MClintDent, MPros<sup>6</sup>/  
 Julia-Gabriela Wittneben, DMD, Dr Med Dent, MMSc<sup>7</sup>/  
 Anja Zembic, Dr Med Dent<sup>8</sup>/Thomas D. Taylor, DDS, MSD<sup>9\*</sup>

## INTRODUCTORY REMARKS

Computer-assisted design (CAD) and computer-assisted machining (CAM) have been increasingly used in implant dentistry over the past 10 years. The continu-

ous improvement of these newer techniques by their developers has started to challenge traditional techniques of fabricating implant-supported prostheses. The premise that there is an improvement in outcome compared with traditional fabrication techniques is fundamental to the use of CAD/CAM. The systematic review by Kapos and Evans is focused on the performance of CAD/CAM prostheses when compared to conventionally manufactured prostheses.

Since most patients provided with oral implants are between 40 and 50 years of age, long-term survival rates for implants and prostheses are expected both from the clinician and the patient to ensure the longevity of the reconstruction. "Long-term" has been specified as a follow-up of at least 5 years. Thus, survival rates and the incidence of biologic, technical, and esthetic events should be based on mean observation periods of at least 5 years. However, implant survival rates are not the only essential consideration when advising the patient on different treatment options. Prosthetic and implant-abutment outcomes need to be considered as well. Different kinds of abutments are available with respect to material (metal and ceramic) and shape (prefabricated and customized, both with various internal designs). At this time, metal abutments are classified as the gold standard, although high-strength zirconia abutments are being utilized more widely and may be an adequate alternative to metal abutments for the clinical use. The systematic review by Zembic et al focuses on the survival rates of metal and ceramic abutments supporting single-implant crowns with a mean observation period of at least 3 years, as sufficient 5-year data were not available. In addition, the occurrence of negative biologic, technical, and esthetic events was evaluated for metal and ceramic abutments.

One of the important decisions in implant prosthodontics is the choice of the connection type of the final restoration to the implant via the screw-retained abutment. The restorative connection can be either screw- or cement-retained. With screw-retained restorations, an abutment or mesostructure may be separate

<sup>1</sup>Professor, Department of Oral Implantology and Prosthetic Dentistry, Academic Center for Dentistry Amsterdam (ACTA), Amsterdam, The Netherlands.

<sup>2</sup>Professor, Division of Fixed Prosthodontics, School of Dental Medicine, University of Bern, Bern, Switzerland.

<sup>3</sup>Private practice, St Brighton, Australia.

<sup>4</sup>Lecturer, Department of Restorative Dentistry and Biomaterials Science, Harvard School of Dental Medicine, Boston, Massachusetts, USA; Private practice, London, United Kingdom.

<sup>5</sup>Professor, Department of Reconstructive Sciences, Center for Biomaterials, University of Connecticut School of Dental Medicine, Farmington, Connecticut, USA.

<sup>6</sup>ITI Scholar, Division of Fixed Prosthodontics, School of Dental Medicine, University of Bern, Bern, Switzerland; Clinical Lecturer, Honorary Specialist Registrar in Restorative Dentistry, Edinburgh Dental Institute, University of Edinburgh, Edinburgh, United Kingdom.

<sup>7</sup>Assistant Professor, Division of Fixed Prosthodontics, School of Dental Medicine, University of Bern, Bern, Switzerland.

<sup>8</sup>Assistant Professor, Division of Fixed Prosthodontics, School of Dental Medicine, University of Bern, Bern, Switzerland; PhD Student, Department of Oral Implantology and Prosthetic Dentistry, Academic Center for Dentistry Amsterdam (ACTA), Amsterdam, The Netherlands.

<sup>9</sup>Professor and Head, Department of Reconstructive Sciences, Center for Biomaterials, University of Connecticut School of Dental Medicine, Farmington, Connecticut, USA.

**Correspondence to:** Daniel Wismeijer, Department of Oral Implantology and Prosthetic Dentistry, ACTA, Free University Research Institute MOVE, Gustav Mahlerlaan 3004, 1081 LA, Amsterdam, The Netherlands. Email: d.wismeijer@acta.nl

*\*On behalf of all the participants and authors of Group 2: Kivanc Akca, Ninette Banday, Robert Carmichael, Anthony Dawson, Jocelyne Feine, John Jones, Juhani Laine, Richard Leesungbok, Robert Santosa, Bruno Schmid, Alejandro Trevino, Sophocles Voyiazis.*

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to the restoration (two-piece) or combined as part of the fabrication procedure (one-piece). In general, both retention types have their advantages and limitations. Clinical and technical issues relevant in making the choice include ease of fabrication, precision, passivity of the framework, retention, occlusion, esthetics, accessibility, retrievability, complications, and costs. The focus of the review by Wittneben et al is on biologic and technical failures and complication rates observed with cement- and screw-retained fixed implant-supported reconstructions.

### Disclosure

All the group members were asked to reveal any conflicts of interest that could potentially influence the outcomes of the consensus deliberations. No such conflicts were identified.

## CAD/CAM TECHNOLOGY FOR IMPLANT ABUTMENTS, CROWNS, AND SUPERSTRUCTURES

### General Comments

The aim of the first systematic review was to answer the focus question "How do CAD/CAM implant-supported prostheses in patients with missing teeth and one or more dental implants perform compared to conventionally fabricated implant-supported prostheses when assessing esthetics, complications (biologic and mechanical), patient satisfaction, and economic factors?" CAD/CAM technology that can be used to predictably facilitate the restoration of dental implants from single-unit cases to complex full-arch reconstructions is currently available. The techniques used to produce the CAD/CAM frames vary significantly between the different investigations. The first described techniques were based on resin patterns placed in a laser scanner to feed information on the contour of the framework into a computer. An identical copy of the resin pattern was then milled out of one piece of titanium. Currently, it is possible to design a complete virtual prosthesis using computer-generated CAD/CAM parts without scanning a physical prototype. For crowns, abutments, and frameworks, CAD/CAM technology is able to provide results that, based on the current literature, are comparable to that of conventional techniques when considering implant survival, prosthesis survival, and technical and biologic complications.

### Consensus Statements

With respect to CAD/CAM technology for implant abutments, crowns, and superstructures, the following statements can be made:

- CAD/CAM technology has been successfully incorporated into implant dentistry.
- The clinical performance of implant-supported prostheses produced using CAD/CAM and conventional techniques is similar over the short term (mean: crowns, 1 year [1 to 1.1 years]; abutments, 3.5 years [1 to 5 years]; frameworks, 4 years [1 to 10 years]).
- The variability of CAD/CAM software and hardware used in fabricating implant-supported prostheses makes comparison difficult.
- The variability of outcome measures and material choices in investigations of CAD/CAM implant-supported prostheses makes comparison difficult.
- The short-term (mean, 3.5 years [1 to 5 years]) survival rate of individually customized CAD/CAM abutments is similar to that of conventionally fabricated or stock abutments.
- The short-term (mean, 4 years [1 to 10 years]) survival rate of individually customized CAD/CAM frameworks is similar to that of conventionally fabricated frameworks.

### Treatment Guidelines

- The implementation of CAD/CAM technologies should lead to acceptable clinical outcomes.
- Continuous training for both the restorative dentist and technician is essential to successfully implement CAD/CAM techniques for the restoration of dental implants.
- There is continuous industry-controlled development in CAD/CAM devices, techniques, and materials. The dentist and technician should be aware that product hardware and software, as well as support, will change with generational advances.
- As the dentist remains responsible for treatment outcomes, it is recommended that he/she play an active role, together with the technician, to carefully control CAD/CAM processes and material selection.
- It is recommended that the dentist approve a virtual final prosthesis (virtual diagnostic wax-up) that dictates abutment/framework design.
- It is recognized that digitally derived prostheses can be remanufactured from stored data sets. It is recommended that digital data sets be stored/protected for this eventuality and that digital technology work platforms maintain programming compatibility/transparency.

### Recommendations for Future Research

- Renew the definitions relating to CAD/CAM techniques:
  1. Complete CAD/CAM product (including abutment, mesostructures, frameworks, and prostheses): The entire design and manufacturing process is software implemented and controlled.
  2. Partial CAD/CAM product (including abutment, mesostructures, frameworks, and prostheses): Some design and manufacturing process steps involve manual intervention.
- Standardization of measured outcomes and study protocols for clinical investigations are recommended.
- Studies on economic impacts and patient-centered outcome measures for new technologies are recommended.

## SURVIVAL RATE AND INCIDENCE OF COMPLICATIONS OF SINGLE IMPLANT-SUPPORTED FIXED RECONSTRUCTIONS

### General Comments

Different kinds of implant abutments are available with respect to material (metal and ceramic) and shape (prefabricated and customized, both with various internal designs). Although metal abutments are classified as the gold standard, high-strength zirconia abutments are being utilized more widely. However, the available data in the literature only covers a limited time span. Therefore, the consensus statements and clinical recommendations are based on a review of the survival rates of metal and ceramic abutments supporting single-implant crowns with a mean observation period of at least 3 years.

### Consensus Statements

- No differences were found between ceramic and metal abutments in clinical performance based upon esthetic, technical, or biologic outcomes.
- No differences were found between the clinical performance of metal abutments with external or internal connections, based upon esthetic, technical, or biologic outcomes (mean, 5 years [3 to 10 years]).
- The reported rate of technical complications is higher than either esthetic or biologic complications (mean, 5 years [3 to 10 years]).

### Treatment Guidelines

- As many different types of zirconia with differing microstructures and performance are being introduced into implant dentistry, they should be obtained from a reputable/qualified manufacturer.
- For anterior and premolar prostheses, zirconia abutments may be indicated. However, they should not be ground, abraded, or adjusted by the clinician or technician following sintering, unless recommended by the manufacturer.
- Ceramic abutments should not replace metal ones for all indications. Preliminary findings reflect an inherent sensitivity of ceramics to design and processing problems; eg, stress concentration, thin walls, sintering, and residual machining flaws.
- The design of full ceramic abutments should not be based on metal abutment design to avoid stress concentrations or the development of unfavorable stresses.
- Caution is recommended in the clinical use of ceramic abutments in molar sites, as their behavior in these sites has not been sufficiently described.
- The performance of bonded titanium-zirconia implant abutments is not yet established. Thus, caution is recommended in the clinical use of such abutments due to insufficient data.

### Recommendations for Future Research

More clinical research is needed for:

- Bonded titanium-zirconia abutments
- Studies on zirconia abutments (both anterior and posterior) longer than 5 years
- Internal versus external implant-abutment connections for both ceramic and metal abutments
- Instrumented and visual esthetic outcomes for ceramic versus metal abutments
- Single- versus multiple-unit prostheses

Minimum standardized data set on outcome measures for future research protocols:

1. Abutment material and fabrication methods
2. Restoration sites (anterior, posterior)
3. Failure type with descriptive information and photographs
4. Timing of failure
5. Gingival indices
6. Soft tissue esthetic outcome(s) with information about tissue thickness
7. Radiographic bone level changes
8. Screw failure

## CLINICAL PERFORMANCE OF SCREW-VERSUS CEMENT-RETAINED IMPLANT-SUPPORTED FIXED RECONSTRUCTIONS

### General Comments

The restorative connection to the implant or abutment can be either screw- or cement-retained. With screw-retained restorations, an abutment or a mesostructure may be separate from the restoration (two piece) or combined as part of the fabrication procedure (one piece). In general, both retention types (screw- and cement-retained) have their advantages and limitations. The consensus statements of this review focus on biologic and technical failures and complication rates observed with screw- and cement-retained implant-supported fixed reconstructions.

### Consensus Statements

- High survival rates can be achieved with both cemented and screw-retained fixed implant-supported prostheses. Neither failure nor complication can be avoided by selecting a prosthesis retention type.
- Cemented all-ceramic prostheses have a higher failure rate than cemented metal-ceramic prostheses. However, no difference was found with screw-retained prostheses.
- Based upon the literature reviewed, the type of cement used does not influence the failure rate of cemented prostheses.
- Technical complications occurred (estimated annual event rate of up to 10%) with both cemented and screw-retained prostheses. In the pooled data, the cemented prostheses exhibited a higher rate of technical complication.
- Screw-retained prostheses exhibited a higher rate of ceramic chipping than cemented prostheses.
- Biological complications can be found (estimated annual event rate of up to 7%) with both cemented and screw-retained prostheses. Cemented prostheses exhibit a higher rate of fistula formation and suppuration.

### Treatment Guidelines

Based on the data in this review, a universal recommendation cannot be made for either cementation or screw retention. However, in a clinical situation that offers a choice of prosthesis retention type, the following recommendations may be made:

Cement retention may be recommended:

- For short-span prostheses with margins at or above tissue level to simplify fabrication procedures
- To enhance esthetics when the screw access passes transocclusally or in cases of malposition of the implant
- When an intact occlusal surface is desirable
- To reduce initial treatment costs
- It is further recommended that the clinician understand that the procedures involved with cement retention for implant-supported crowns are not simple and should be carried out with great caution.

Screw retention may be recommended:

- In situations of minimal interarch space
- To avoid a cement margin and thus the possibility of cement residue (this may be particularly important if the prosthetic margin is placed submucosally, since it has been shown to be more difficult to completely remove cement residue from margins placed > 1.5 mm submucosally)
- When retrievability is of importance
- In the esthetic zone, to facilitate tissue contouring and conditioning in the transition zone (emergence profile)
- To facilitate screw retention, it is recommended that the implant be placed in a prosthetically driven position.

## RECOMMENDATIONS FOR FUTURE RESEARCH

- Standardization of outcomes for clinical investigations is recommended.
- Improved protocols for chairside cementation should be developed.
- Combined prostheses retention types should be tested (eg, bonding base).
- Ceramic chipping occurs frequently. Reporting of ceramic chipping should include the severity and location of the chipping. This should also be related with patient-centered outcomes.
- Details of the restorative and technical procedures, which may influence prostheses survival, should be reported.
- Prosthetic factors, such as the material of the components used, should be reported in greater detail.