OSSTEM
IMPLANT

2025 1st

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GLOBAL CONSENSUS TEMPORARY REPORT

PROSTHODONTICS DIVISION

Indice

Background and Introduction

The aim of a consensus conference is to provide guidelines from the available scientific evidence, and the clinical evidence, thought a consensus made by researcher/professor, and clinicians. Guidelines may support implant community to improve success of their treatments for the benefit of patients, reducing possible complications. Guidelines may also provide agreement for correct terminology, as well as concepts. Osstem Implant community promotes Consensus Conferences since 2017.[1-3]

[1]Tallarico, M. et al. Patient-centered rehabilitation of single, partial, and complete edentulism with cemented- or screw-retained fixed dental prosthesis: The First Osstem Advanced Dental Implant Research and Education Center Consensus Conference 2017. Eur J Dent 12, 617–626 (2018).
[2]Tallarico, M. et al. Implant Fracture: A Narrative Literature Review. Prosthes 3, 267–279 (2021).
[3]Tallarico, M. et al. Accuracy of Surgical Templates with and without Metallic Sleeves in Case of Partial Arch Restorations: a Systematic Review. J Dent 103852 (2021) doi:10.1016/j.jdent.2021.103852.

Osstem Implant Community (OIC) is organizing this Global Consensus Meeting with the aim to propose Global Standards for Implant Dentistry for correct terminology and concepts.

Experts from across the globe will meet before online, and finally in presence in Seoul to discuss the selected topics, carrying out evidence-based reviews and develop preliminary statements and recommendations through collaboration and discussion. The goal was to reach a robust consensus for these topics, that can be submitted for publication to the benefit of Osstem and not Osstem Users (scientific community).

As Chairman I would like to extend a huge thank you to Osstem Implant and to everyone who joined the Osstem Global Consensus Meeting. I'm really excited to see the impact of these newly formed consensus reports and hope they assist in guiding the future of OIC members.

I know there is still a long way to go. Our work does not stop here, and we look forward to continuing to strive towards a brighter future for implant dentistry, at many more meetings in the years to come. I'm sure that working together, OIC can reach successful results, and can give visibility they deserve. Osstem Implant is the most sold implant in the world, and potentially, OIC could be the most representative scientific community in the world. Only working together, across the globe, without limits, we can reach this ambitious goal, to be the biggest scientific community in the world.

Methodology

Doctors/professors (AUDIENCE) were selected based on their curricula to participate as AUDIENCE and/or SCIENTIFIC COMMITTEE for three different topics: surgery, prosthesis, and digital. The present paper is written as part of the Prosthodontics Division.

Each participant proposed one or more prosthetic topics to be discuss during the Global Consensus Meeting. At the kick-off meeting the topics and the chairman were defined (CHAIR). After that, topics, and relative presenters were selected (SCIENTIFIC COMMITTEE). Each presenter reviewed and summarized available data and other relevant informations regarding the PICO questions and presented the evidence to the conference audience. Chair and CO-CHAIR (relevant team of Osstem Implant) were responsible for guiding and controlling the proceedings of the Global Consensus Meeting, as well as, the executive

discussions to help to reach consensus. Each of the three sessions had a different and specific chair and co-chair.

The role of the Chair and co-chair was to provide opinions to the responsible presenters (also named speakers, or member of the scientific committee) thought a review of the their works. After that, the presenters were invited to review their works according to the decision of the chair and co-chair, also named (DECISION MAKING PANEL). Finally, the works will be presented to the AUDIENCE as following:

1. Preliminary on-line sessions were organized by co-chair to allow the speakers to present their works to the AUDIENCE and to collect preliminary advices.
2. Finally, the Evidence will be presented by the scientific committee (selected presenter/speaker) to the audience (conference) in three public (open) parallel sessions (one for each topic) followed by a discussion. These off-line (in presence) conferences will be held in Seoul, during the Osstem World Meeting. A person in charge will record the discussion (if needed) and the outcomes. The purpose of these conferences is to allow the decision making panel to further deliberate on the evidence and discussion to reach consensus on the three topics. The result will be a draft consensus statement.

Results

Relevant team of Osstem Implant identified the Audience for the Global Consensus Meeting, Prosthodontics Division (Table 1).

Dr. Lee Soo-young	Prosthodontics	Seoul Line Dental Clinic	South Korea
Dr. Cho Young-jin	Prosthodontics	Seoul Deep-rooted Dental Clinic	South Korea
Prof. Noh wan-tae	Prosthodontics	Kyung Hee University	South Korea
Prof. Kim Jong-un	Prosthodontics	Yonsei University college of Dentistry	South Korea
Prof Okubo Chikahiro	Prosthodontics	Tsurumi University School of Dental Medicine	Japan
Prof. Marco Tallarico	Prosthodontics and oral surgeon	University of Sassari	Italy
Dr. Felipe Aguirre	Prosthodontics	-	Chile
Dr. Recep Uzgur	Prosthodontics	-	Turkiye
Dr. Gaetano Noè	Prosthodontics	Private practice	Italy
Eugene Kim	Prosthodontics	Private practice, Buena Park	United States

Table 1. Audience for the Global Consensus Meeting, Prosthodontics Division.

Prosthodontics	What are the prosthetic recommendation to reduce the risk of implant fracture?	Prof. Marco Tallarico	Tallarico recommendation
	What are the prosthetic triggers to reduce the risk of periimplantatis?		
	Is the accuracy of digital impression and/or fully digital workflow in partial restoration reliable?		
	Is the accuracy of digital impression and/or fully digital workflow in complete arch restoration reliable?		
	Appropriate desgn for optimal healthy transition zone	Dr. Lee Soo-young	
	Placement position & number of Implants for All on x	Prof. Noh Kwan-tae	
	Use and success with prosthetic materials used for implant-supported restorations	Dr. Recep Uzgur	
	Use and Success Current Implant Supported Prosthetic Materials		
	Development of new scanbody designs that match intraoral scanning technology	Dr. Felipe Aguirre	Tallarico recommendation
	Discussion for ER Type(Implant prosthesis type) terminology	Dr. Cho Young-jin	
	Replace term All-On-4 with FullArch Treatment / FullArch Solution	Osstem	Nobel biotech's copyrights

The AUDIENCE and the CO-Chair (from Osstem) nominated during the first kick-off meeting, the Chair to support conference arrangements and review process. The Chair was defined in the person of prof. Marco Tallarico, University of Sassari, and private practice in Rome. After preliminary selection of the AUDIENCE, Chair and co-chair were asked to select two more members of the SCIENTIFIC COMMITTEE, also potential presenter. The Chair proposed dr. Gaetano Noè, elected president of the Italian Academy of Prosthodontics. The second enrolled member was.

Figure 1. Proposed topics by all the AUDIENCE of the Prosthodontic Division. Errata Corrige. In the figure is reported Nobel biotech, but it is Nobel Biocare.

Part	No.	Issue	Speaker
Prosthodontics	1	What are the prosthetic recommendation to reduce the risk of implant fracture?	Prof. Marco Tallarico
	2	Development of new scanbody designs that match intraoral scanning technology	Dr. Felipe Aguirre
	3	- Pacament posotopm & number of implants ffor All on X - Replace term All-On-4 with FullArch Treatment / FullArch Solutrion	Prof. Noh Kwan-tae
	4	Accuracy of 3D printed models in prosthodontics.	Dr. Gaetano Noè

Figure 2. Selected topics by the Chair and co-chair.

After received and discussed the topics (also named Issues, Figure 1) from the AUDIENCE, The Chair and co-chair selected four main topics, and relative presenters for reviews and discussion (Figure 2).

Before starting the reviews by the presenters the Chair prepare a DROPBOX folder(*) as storage for all the documents, and sent an email on December 18th 2023 to give some recommendations the the SCIENTIFIC COMMITTEE, including AGREE guidelines that was attached as supporting material. In Brief, the Chair ask to follow as much as possible the AGREE guidelines preparing their review papers. The most important points in the AGREE guidelines are the following:

1. Selection and definition of FOCUSED and PICO questions and corresponding selection criteria.
2. Well defined Search Strategy and Methods to identify relevant evidence on the selected topics (review process).
3. Identify and report the criteria used to select (i.e., include and exclude) the evidence.
4. Describe the strengths and limitations of the evidence.
5. Describe the methods used to formulate the recommendations and how final decisions will be reached. Specify any areas of disagreement and the methods used to resolve them.

(*) https://www.dropbox.com/scl/fo/p3fbf1b7xadlziz64xliy/h?rlkey=ua5xla6img8vr4bcay8txpr0g&dl=0

Chair and co-chair reviewed the submitted papers/presentation from the presenter according to the GRADE approach, to Grading of recommendations (guidelines) assessment, development and evaluation. GRADE approach is based on common, sensible, and transparent approach to Grading: quality of evidence, strength of recommendations. A summary of the main topics reported on the GRADE guidelines are following reported:

1. Review and assessing the quality of the evidence considering 5 factors that can lower and 3 that can raise the evidence.
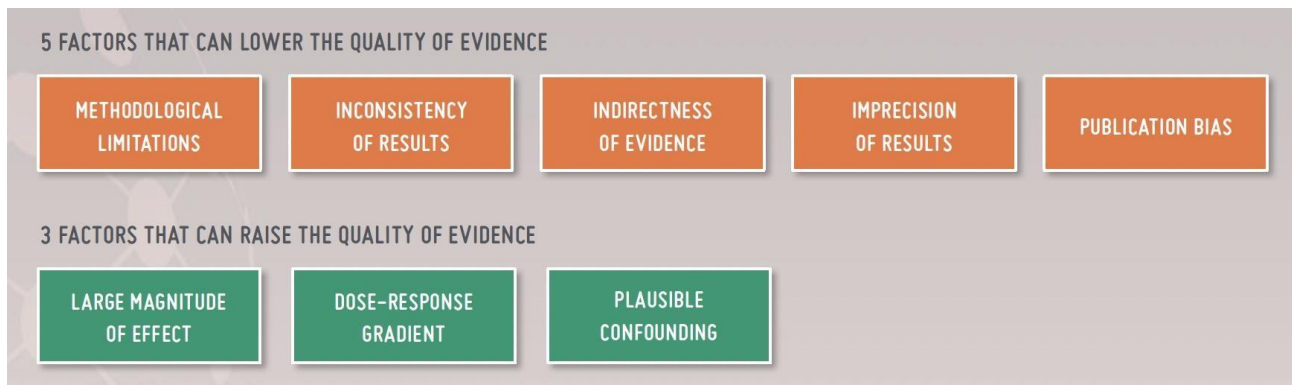
2.How to move from Evidence to recommendations (weak versus strong recommendations).

Figure 3. Factors that can lower and raise the quality of evidence according to the GRADE approach.

An important part of the Consensus Meeting should be to declare any potential financial, professional and/or personal Conflict of Interest to be made before consensus meeting by each participant (AUDIENCE, SCIENTIFIC COMMITTEE, CHIAR, CO-CHAIR). However, due to this Global Consensus Meeting has been organized by Osstem Implant company, most of the AUDIENCE is made by Osstem Users/KOL. Only a few part of the members is not Osstem Users. Moreover, Osstem Implant Company is providing a fee for the participation is these Global Consensus Meeting. Finally, Co-Chair(s) are from Osstem Implant. So, all the participants have conflict of interest to declare as following:

Conflict of interest statement:

All the participants are consultants for Osstem Implant for this Global Consensus Meeting, and most of the participants are consultants and/or key opinion leader fo the same implant company. Osstem Implant provided funding for this research project including an economical reimbursement for all the participants. However, all provided data belonged to the authors and never the manufacturer interfere with the conduct of this Global Consensus Meeting, or the publication of its results.

TOPIC Number 1 - Prof. M. Tallarico

Title: What are the prosthetic recommendations to reduce the risk of implant fracture?
Presenter: Prof. Marco Tallarico

Background

Implants fracture is a rare but possible complication that leads to implants failure after prosthesis delivery. Mechanical properties play a key role in the failure of dental implant systems.

Methodology

The author proposed an upgrade of a Narrative Review published in 2021.

1. Focused question has been reported: there were any possible factors influencing the fracture of dental implants?
2. Search Strategy and Methods have been clearly reported in the manuscript and in the presentation.
3. The inclusion and exclusion criteria have been clearly reported in the manuscript and in the presentation.
4. Strengths and limitations of the evidence have been reported in the published manuscript (2021).
5. The author proposed strength and effective conclusions based on the evidence, and proposed several questions to formulate guidelines, and to reach the consensus. The author also describe the methods used to formulate the recommendations and how final consensus. The Audience can proposed different opinions and the AUDIENCE will discuss any disagreement with the aim to reach the consensus. Finally, dichotomy questions have been provided. Due to the AUDIENCE is composed by 10 members, the proposal is to give double vote to the Chair in case of parity (5 versus 5).

Grading of the evidence

The selected topic is well recognized in the scientific literature. However, the evidence is based on retrospective study. Due to the nature of the topic (implant fracture) it is not possible to propose well designed aimed to evaluate fracture versus not fracture of the implants. However, it is the Chair opinion that it is possible to draw straight guidelines from the available evidence to guide the clinicians in the correct diagnosis and treatment plan, with the aim to reduce the risk of implant fracture.

Conclusions for the author

The author prepared a well design literature review, in agreement with AGREE guidelines. Level of evidence is sufficient for the purpose of this Global Consensus Meeting. The method to reach the consensus is valid and reported following this paragraph. No further action are needed.

Questions to reach the consensus

Osstem Global Consensus Meeting

WHAT ARE THE PROSTHETIC RECOMMENDATION TO REDUCE THE RISK OF IMPLANT FRACTURES?

Prof. Marco Tallarico

1. Do you agree to define dental implant (or fixture) fracture as: irreversible mechanical complication of multifactorial origin?

⭕ Yes
⭕ No
⭕ Propose other definition

2. Do you agree with the conclusion of this narrative review? Prevention, prosthetically driven implant planning, proper treatment plan (implant diameter and design) are mandatory. Risk factors: overloading, bruxers, bone loss.

⭕ Yes
⭕ No
⭕ Propose different conclusions

3. Do you agree that single, malpositioned implants are at higher risk of fractures, so that prosthetically driven implant position is mandatory, hence, computer guided surgery should be recommended (gold standard)?

⭕ Yes
⭕ No

4. Do you agree that a wide range of peri-implant bone thickness around implants(1 to ≥2 mm related to soft tissue quality/quantity) is mandatory to reduce risk of bone resorption, and consequently, higher horizontal forces?

⭕ Yes
⭕ No

5. Do you agree that anticipating supracrestal tissue height establishment by adapting the apico-coronal implant position in relation to the mucosal thickness may be effective to prevent the marginal bone loss?

⭕ Yes
⭕ No

6. Do you agree that implants should be placed maximum up to 2 mm deeper in the bone (thin biotype, immediate implants, esthetic reasons)?

○ Yes
○ No
○ Propose different considerations

7. Do you agree that TS implants of minimum 4.5 mm of diameter are recommended for the replacement of single molars?

○ Yes
○ No
○ Propose different considerations

8. Do you agree that TS implants of minimum 4.0 mm of diameter are recommended for replacement of single premolars?

○ Yes
○ No
○ Propose different considerations

9. Do you agree that, in case overloading is expected (bruxism, cantilevers, etc.) and/or when higher marginal bone loss is expected (thin biotype, periodontally compromised patients, posterior area, mandible)? SS implants should be recommended in single molars replacement?

○ Yes
○ No
○ Propose different considerations

10. Do you agree that original prosthetic components must to be used in order to reduce the risk of screw loosening, and consequently, risk of fracture?

○ Yes
○ No

11. Do you agree that original screws (definitive screws, EbonyGold screws) must to be tightened with the recommended torque, only one time (no laboratory use), and re-tightened, again after 10 minutes to compensate the preload?

○ Yes
○ No

12. Do you agree that slightly occlusal contacts in static occlusion, and slightly or no occlusal contacts in dynamic occlusion, as well as, a variable Immediate Side Shift (ISS), should be used, independently by the occlusal scheme? This means to work with at least semi-adjustable dental articulators or digital ones.

⭕ Yes
⭕ No
⭕ Propose different considerations

13. Do you agree that in bruxers, proper restorative materials, and reduced occlusal areas, should be used, particularly in the posterior areas (premolars and mandibular molars), as well as, a night guard should be delivered as protection.

⭕ Yes
⭕ No
⭕ Propose different considerations

14. Do you agree that occlusal controls must to be done at any follow-up visit (at least once a year) lifetime, (including a check of the contact points)?

⭕ Yes
⭕ No
⭕ Propose different considerations

15. Do you agree that smaller implant-abutment connection (KS implants) could reduce but not eliminate the risk of implant fractures, however, evidence is still needed to define the right use (diameter) in relation to the area?

⭕ Yes
⭕ No

Prof. Marco Tallarico's results

Eight out of 10 professors (including the author) answered the questions to reach the consensus.

1. Prof. Gaetano Noè agreed to all the proposed questions (15 out of 15).

2. Jong Eun Kim agreed, with one note (question n° 15), to all the proposed questions (15 out of 15).

"In terms of the implant body, I agree. And I think it should be supported by long-term clinical studies. However, my concern is that by reducing the diameter of the connection, the taper of the beveled joint area of the internal connection has increased, and we need to see if this does not increase the strain on the screw even if it is very slight. We also need to observe that the smaller diameter screws do not cause technical problems."

I agree. The note will be add in the final text.

3. Chikahiro Ohkubo agreed to all the proposed questions (15 out of 15).

4. Y.J. Cho agreed to 14 of the proposed questions (14 out of 15). About the question 12th he proposed different consideration:

"Believing that there is no need for slight occlusal contact in static occlusal situation."

I think also depend by antagonist, but there is no evidence on that. This note will be taken into consideration in the final report.

5. Marco Tallarico agreed to all the proposed questions (15 out of 15).

6. F. Aguirre agreed to all the proposed questions (15 out of 15). However, he added to the question 12th the follow:

"Even distribution and force of contacts and no contact in cantilever regions."

I agree. This consideration will be added in the final report.

7. Eugene Kim agreed to 12 of the proposed questions (12 out of 15). Two were no and one additional propose.

- NO. Question 7: I recommended 5 mm diameter for molars.
- NO. Question 8: I recommended 4.5 mm diameter for premolars.

I partially agree. Due to 7 out of 8 Authors answered yes. The consensus was reached with the proposed question. However, I will add "at least" in order to take into consideration also this proposal.

- Different proposal. Question number 6: Implants should be placed -4 to -5 mm subgingival.

I disagree. In a systematic review on the keeping position of the implants, only one study reported 3 mm deeper implants. In the literature, most of the study considered 1 to 2 mm. 3 mm could

8. Recep Uzgur agreed to all the proposed questions (15 out of 15).

Consensus

Focused question: there were any possible factors influencing the fracture of dental implants?

A literature search strategy encompassing the literature in English from 1967 up to December 2023 was performed to identify relevant studies meeting the inclusion criteria. The PubMed database of the U.S. National Library of Medicine has been consulted using a combination of Boolean keywords including MeSH (Medical Subject Headings), free text terms, and filters with the following combination: Search: ("Dental Implants/adverse effects" [Mesh] AND "fracture").

Filters: Abstract, Dental journals, English. Screening was performed independently by two expert examiners (SSM, FMC).

The following inclusion criteria were defined for the selection of the articles:

- Papers written in the English language;
- Clinical examination of human patients reporting incidence of implant fracture;
- Prospective and retrospective observational studies;
- Systematic reviews; meta-analysis; narrative reviews, and consensus conference;

  Articles were excluded if they were: animal or in vitro studies; Reports with less than 15 patients; Reports of implant outcomes with less than one year on function.

A total of 136 (96+40) articles were found according to the search criteria. After abstracts evaluation and duplicates removal, 33 (22+11) articles were deemed useful for the aim of the present review. A manual search using personal contacts and references of published works allows to include another two+two articles, resulting in a total of 37 (24+13) manuscripts. Finally, after full-text articles selection and reading, 12 (8+4) manuscripts were included according to the inclusion/exclusion criteria. Of these, two were systematic reviews, and 10 (6+4) were retrospective evaluations.

Implants fracture is a rare but dramatic complication which can be due to multifactorial origin Mechanical properties play a key roleThe incidence is about 0.48%.

Prevention of mechanical issues is mandatory. Prevention of marginal bone loss is also of importance. Poor implant planning, implant design/diameter, and occlusal overloading were the most common variabilities associated with implant fracture. More frequent in bruxers, single restorations, and mandible. Screw loosening ofter occur in advance.

Global Consensus

◆ Definition of dental implant (or fixture) fracture: an irreversible mechanical complication of multifactorial origin.

◆ Prevention, prosthetically driven implant planning, proper treatment plan (implant diameter and design) are mandatory to reduce the risk of implant fracture. Additional risk factors are: overloading, bruxers, peri-implant bone loss.

◆ Single, malpositioned implants are at higher risk of fractures, so that prosthetically driven implant position is mandatory, hence, computer guided surgery should be recommended to avoid malpositioned implants.

◆ A wide range of peri-implant bone thickness around implants (1 to ≥2 mm related to soft tissue quality/quantity) is mandatory to reduce risk of bone resorption, and consequently, higher lateral forces on the implant neck.

◆ Anticipating supracrestal tissue height establishment by adapting the apico-coronal implant position in relation to the mucosal thickness may be effective to prevent the marginal bone loss.

◆ Implants should be placed maximum to 2 mm deeper in the bone. The vertical position should be adapted in relation to the soft tissue quality and quantity and esthetic demands.

◆ TS implants of at least 4.5 mm of diameter are recommended for the replacement of single molars?

◆ TS implants of at least 4.0 mm of diameter are recommended for replacement of single premolars?

◆ In case overloading is expected (bruxism, cantilevers, etc.) and/or when higher marginal bone loss is expected (thin biotype, periodontally compromised patients, posterior area, mandible)? SS implants should be recommended in single molars replacement.

◆ Original prosthetic components must to be used in order to reduce the risk of screw loosening, and consequently, risk of fracture.

◆ Original screws (definitive screws, EbonyGold screws) must to be tightened with the recommended torque, only one time (no laboratory use), and re-tightened, again after 10 minutes to compensate the preload.

◆ Well distributed, normal or slightly occlusal contacts in static occlusion, with no contact in cantilever regions, should be used. In addition, slightly or no occlusal contacts in dynamic occlusion, as well as, a variable Immediate Side Shift (ISS), should be used, independently by the occlusal scheme. This means to work with at least a semi-adjustable dental articulators or digital ones.

◆ In bruxers, proper restorative materials, and reduced occlusal areas, should be used, particularly in the posterior areas (premolars and mandibular molars), as well as, a night guard should be delivered as protection.

◆ Occlusal controls must to be done at any follow-up visit (at least once a year) lifetime, (including a check of the contact points).

◆ Smaller implant-abutment connection (KS implants) could reduce but not eliminate the risk of implant fractures. However, by reducing the diameter of the connection, the internal tapered implant-abutment joint increases (from 11° to 15°), with potential increased strains. In addition, smaller diameter screws

may have technical problems." For the latter, evidence from long-term clinical studies is needed to define the right use (diameter) in relation to the area.

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TOPIC Number 2 - Dr. Felipe Aguirre

Title: Development of new scanbody designs that match intraoral scanning technology
Presenter: Dr. Felipe Aguirre

Background

Intraoral scanning (IOS) accuracy can not ensure passive fit for implant complete arch rehabilitations.

Methodology

The author analyzed some publications and finally proposed new prototype of scanbody for full arch restorations.

1. Focused question has been reported: Is the intraoral scanning technique accurate enough to obtain passive fit for implant complete arches in 2024?
2. Search Strategy and Methods have **not** been reported in the presentation.
3. The inclusion and exclusion criteria have **not** been reported in the presentation.
4. Strengths and limitations of the evidence have **not** been reported in the presentation.
5. No any method to reach the consensus was been reported.

Grading of the Evidence

There is not a clear study design and methodology, so it is no possible to evaluate the grading of the proposed evidence.

Conclusions

In the present form, it is not possible to reach any consensus. The focused question is oriented to the accuracy of actual scanbody for implant-supported full arches. However, the selected topic is quite different than the proposed focused question. The proposed focused question only allows to define the background of this research. As focused question I would expect something like: What is the greatest scanbody design (including material) and technique for implant-supported complete arch restorations? The presentation (background and initial proposed literatures) confirmed that the author is mostly focused on the accuracy of IOS in implant-supported full arches (this must to be only the background). After that, the author presented how the design and material of the scanbody may influences the final accuracy. This is a good point to reach a consensus. However, risk of bias are high due to there is no any search strategies, criteria, quality control, limitations, etc. Distance and angulation depend by the implant position, so I'm not sure these are important (but no criteria have been reported). I think the author can delete them. Reverse scanbody has both different designs, but also they required a different technique. So I think these point are crucial and must to be better developed. Prototype of revers scanbody must to be considered as adjunctive material due to the lack of evidence. All the conclusions on Osstem product should be moved as adjunctive material. Then, please, don't report the background in the conclusions "point 2". Conclusions must reflect the results of the literature research. Once again, the focused question must to be revisited. Another conclusion is: "There is a need for

clear protocols…" I agree with you but our goal is not to conclude this. Our goal is to find a consensus on the best protocol… the best scanbody design… if possible. For example… if you conclude that revers scanbody are more accurate that conventional scanbody, to reach the consensus you can propose some questions such as… are you agree that revers scanbody should be used … The fact that Osstem doesn't produce them, should not influence the results of the literature research. Of course, the results of this Global Consensus Conference can push Osstem to develop them. So please check everything, give right conclusions, and propose a way to reach the consensus. Last but not the least, what about Photogrammetry? You mentioned in some researches, but I failed to find final conclusions on this technique. I know this is accurate. Once again, the fact that Osstem has not original component to work with the photogrammetry is not a reason to avoid it. Thanks.

After the first feedbacks, the author proposed a form to be fill to reach the consensus.

Questions to reach the consensus

OSSTEM GLOBAL CONSENSUS MEETING

FULL ARCH IMPLANT RESTORATIONS: PASSIVE FIT AND ACCURACY OF INTRAORAL SCANNERS AND SCAN BODIESDIGITAL IMPRESSIONS

Dr. Felipe Aguirre.

Do we need "Passive Fit"in the full-arch implant retained restorations? YES–NO –Other

"Passive Fit"is not defined in the Glossary of Prosthodontic Terms of JPD. The Term "Fit"is defined as: "to insert or adjust until correctly in place; to make or adjust to the correct size or shape, i.e., to adapt one structure to another, as the adaptation of any dental restoration to its site, in the mouth."Do you think there is a need to define Passive Fit? YES–NO –Other

Do you agree with this definition?Passive Fit: The absence of static loads and strains between a screw retained implant-supported prosthesis and all abutments, implants and surrounding bone matrix, when placed intraorally with all screws fully torqued. YES–NO –Propose Other

Do you agree that Passive Fit is vital to prevent biological and mechanical complications of implant-supported restorations? YES–NO –Other

Do Intraoral Scanners and current Scan Bodies provide enough accurate digital impressions to achieve Passive Fit for full-arch screw retained implant restorations over MU abutments? YES–NO –Other

Do Intraoral Scanners and current Scan Bodies provide enough accurate digital impressions to achieve Passive Fit for full-arch screw retained implant restorations over non hexed implant connections? YES–NO –Other

Do Intraoral Scanners and current Scan Bodies provide enough accurate digital impressions to achieve Passive Fit for screw retained implant partial restorations over 3 MU abutments? YES–NO –Other

Do Intraoral Scanners and current Scan Bodies provide enough accurate digital impressions to achieve Passive Fit for screw retained implant partial restorations over 3 non hexed implant connections? YES–NO –Other

Do Intraoral Scanners and current Scan Bodies provide enough accurate digital impressions to achieve Passive Fit for screw retained implant 3-unit restorations over 2MU abutments? YES–NO –Other

Do Intraoral Scanners and current Scan Bodies provide enough accurate digital impression sto achieve Passive Fit for screw retained implant 3-unit restorations over 2non hexed implant connections? YES–NO –Other

Do you agreeScan-Analogs and extraoral scanning provide enough accuracy to achieve passive fit for full-arch implant retained restorations? YES–NO –Other

Do you agree that extraoral scanning for Scan-Analogs should be performed with Lab.desktop scanners instead of extraoral use of an intraoral scanner?YES–NO –Other

Do you agree OSSTEM should provide new designs and protocols to secure passive fit within digital workflows?YES–NO –Other

Dr. Felipe Aguirre's results

Six (Y.J. Cho, J.E.Kim, Chikahiro Ohkubo, M. Tallarico, G. Noè, R. Uzgur) out of 10 professors sent the answers. Of these:

- All (six) agree that Passive fit is mandatory for full arch, implant retained restorations.

- All (six) agree that we need a clear definition of "Passive Fit".

- Four authors plus the speaker agreed with the following definition:

"The absence of static loads and strains between a screw retained implant-supported prosthesis and all abutments, implants and surrounding bone matrix, when placed intraorally with all screws fully torqued.

Prof. Tallarico and Prof. Noè proposed a slight different definition:

§*Passive fit: the absence of any strains and static loads between a firmly, screw-retained, implant-supported prosthesis and the implant-abutment interfaces* and the surrounding bone, when are onto the model or intraorally with at least one screw tightened.*

* Implant-abutment interface or crestal module is the portion of a two-piece metal dental implant, designed to hold the prosthetic components in place and to create a transition zone to the load bearing implant body.

§ One of the most common method to evaluate the passive fit is the Sheffield test. The Sheffield Test clearly shows the fit or misfit of the mesostructure on the model and in the mouth. With one screw, the mesostructure is firmly screwed onto the model on the distally positioned implant replica or abutment for checking (**Eisenmann** 2004).

The superstructure of the screw retained implant-supported prosthesis can be considered passive if it does not generate any static loads and strains within the prosthesis or in the surrounding bone matrix. **Jemt** defined the passive fit as a level of fit which will not produce or cause any long-term clinical problem.

Finally, passive fit is defined as:

The absence of strain, static load or separation of components between a screw-retained implant-supported prosthesis, the implant-abutment interfaces, and the surrounding bone, when installed intraorally and onto the working model (when present), with all of the screws tightened individually and together.

- All (six) plus the speaker agree that Passive Fit is vital to prevent biological and mechanical complications of implant-supported restorations.

- All (six) agree to the questions number 5 and 6. IOS and current scan bodies **don't** provide sufficient accuracy for full arch restorations at both implant (non HEX) and abutment (MU) levels.

- Prof. Tallarico and prof. Noè agree that 2- and 3-unit impressions/restorations can be accurate enough using IOS and actual scanbody on both implant (non HEX) and abutment (MU) levels. Questions number 7-10. But using a model-free approach. On the contrary, the use of CAD/CAM printed model is to be evaluate in a separate topic.

Prof. Y.J.Cho agree that IOS and actual scan bodies provide enough accurate digital impressions to achieve passive fit for screw retained implant partial restorations over both 2- and 3-unit only using multi abutment (MU, abutment level), but not at implant level (non HEX).

Prof. J.E.Kim considered not accurate IOS and actual scanbody even for 2- and 3-unit restorations independently by abutment (MU) or implant level (non HEX).

For Prof. CHIKAHIRO OHKUBO Intraoral Scanners and current Scan Bodies provide enough accurate digital impressions to achieve Passive Fit for most of cases of screw retained implant 3-unit restorations over 2 non hexed implant connections. However, they cannot provide for only few cases where long distance between two implants, deeper implant placement, technical error of scanning, or so on.

For Dr. R. Uzgur, considered not accurate IOS and actual standby even for 2- and 3-unit restorations independently by abutment (MU) or implant level (non HEX).

For (plus the speaker), against two, agree that Intraoral Scanners and current Scan Bodies can provide accurate enough accurate digital impressions to achieve Passive Fit on 3-unit, implant-supported restorations, independently by the IAI. However, three authors propose some notes. So, the consensus can be reached with notes, also suggesting caution.

For all (six) the involved professors (plus the speaker), extraoral scanning (assuming to use a desktop lab scanner) seems to be the gold standard. Scan-Analogs and extraoral scanning provide enough accuracy to achieve passive fit for full-arch implant retained restorations. According to prof. CHIKAHIRO OHKUBO, if verification index using ladder frame and auto-polymerized resin were recorded, Scan-Analogs and extraoral scanning can provide enough accuracy to achieve passive fit for full-arch implant retained restorations. If not, conventional impressions using silicone impression material were made, they cannot provide.

All the professors, except prof. CHO (not experience in this filed) suggested that new scan body design for full arch restorations should be provide, and able to be scanned with a desktop scanner. For prof. KIM, they (scan bodies) should be designed to minimize the sharp edges of the scanbody and make sure the coordinate settings of the library are perfect. For dr. Aguirre and prof. Marco Tallarico, reverse scan body should be provided.

Consensus

Title: Complete Arch Implant Passive Fit: Scan Body Design and Intraoral Scanning
Presenter: Dr. Felipe Aguirre

Focused question: Is the intraoral scanning technique accurate enough to obtain passive fit for implant complete arches in 2024?

Narrative review.

Global Consensus

- Definition of "passive fit": The absence of strain, static load or separation of components between a screw-retained implant-supported prosthesis, the implant-abutment interfaces, and the surrounding bone, when installed intraorally and onto the working model (when present), with all of the screws tightened individually and together.

- "Passive Fit" is mandatory for successful full-arch implant retained restorations, and a clear definition is needed.

- "Passive Fit" is mandatory to prevent biological and mechanical complications of implant-supported restorations.

- Intraoral scanners and current scan bodies don't provide enough accurate digital impressions to achieve passive fit for full-arch screw retained implant restorations over both multi unit abutment and non hexed implant connections.

- To the day this consensus was conducted, there is still not sufficient scientific and clinical evidence to reach a global consensus. Even if actual IOS and scan bodies may provide enough accurate digital impression for 3-unit restorations, many variabilities should be considered, such as, intraoral scanner's technology, learning curve, digital workflow, etc. Caution must be done when using these protocols.

- Scan analogs and extraoral scanning may provide enough accuracy to achieve passive fit for full-arch implant retained restorations. Scan bodies should be designed to minimize the sharp edges of the scanbody with perfect coordinate settings of the libraries.

- A suggestion for the company is that OSSTEM should provide new scan analogs, and libraries to secure passive fit for full arch restorations.

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TOPIC Number 3 - Prof. Kwantae Noh

Title: Placement position & number of implant(s) for All-on-X
Replace terminology All-on-X with Full arch treatment / Full arch solution

Presenter: Prof. Kwantae Noh

Background

I failed to found a real background, maybe because the topic is not clear for me. I understand the purpose of this work is to try to find a terms able to replace the concept of "All-on-4". However, most of the presentation is focused on the itself. Only a few nods have been made on other treatment concepts for full arch restorations, including same or different number and implant positions.

Methodology

The author proposed an upgrade of a Narrative Review published in 2021.

1. Focused question has **not** clearly reported: replace terminology on All-on-X Full arch treatment(s) / Full arch solution(s) is not a focused question.
2. Search Strategy and Methods have **not** been reported in the presentation.
3. The inclusion and exclusion criteria have **not** been reported in the presentation.
4. Strengths and limitations of the evidence have **not** been reported in the presentation.
5. The author reviewed some manuscripts on the All-on-4 concept without any methodology. Moreover, only a few cases that match the "possible" topic (implant number/position) are reported. For example, if some comparisons between 4 and 6 implants (number and position) are needed, some studies like the following should be considered.[1] Finally, no a clear way to reach the consent has been reported.

[1]Tallarico, M., Meloni, S. M., Canullo, L., Caneva, M. & Polizzi, G. Five-Year Results of a Randomized Controlled Trial Comparing Patients Rehabilitated with Immediately Loaded Maxillary Cross-Arch Fixed Dental Prosthesis Supported by Four or Six Implants Placed Using Guided Surgery. Clinical Implant Dentistry and Related Research 18, 965–972 (2016).

Grading of the Evidence

There is not a clear study design and methodology, so it is no possible to evaluate the grading of the proposed evidence.

Conclusions

In the present form, it is not possible to reach any consensus. The focused question is not clear. No any methodology has been used. Global consensus is based on rigorous research work. Without this, the risk is that the consensus is based only on personal opinion and it can not be used globally for the international scientific community. However, the aim of this Global Consensus Meeting is also to replace some terminologies, such as All-on-4. Honestly speaking, I would like to invite all of us should to reflect on some crucial considerations.

1. All-on-4 is a well recognized (in the international scientific literature) treatment protocol.
2. It is a trademark of Nobel Biocare. However, the "™" refer to the treatment protocol. There is no any problem to use the term All-on-4 if the treatments are performed in agreement with the original protocol.
3. The "™" All-on-4 can not be used by Osstem for commercial purpose, but It can be used in scientific contests.

So in my personal opinion, from a scientific point of view, **there is no the need to replace the term "All-on-4"**, and, honestly speaking, **we can not replace the name**. Maybe we can give a new name to a new tested treatment protocol, if we have it. In the literature, there are other described treatment modalities for full arch treatments. For example, V-II-V (Agliardi et al.), pterygoid implants, zygomatic implants, etc. The last, zygomatic implants, is a generic term that could be used. Straumann named Quad zygoma a specific, published, treatment protocol.[2]

From this Global Consensus Meeting, I understood, Osstem needs a different term to be used for a commercial purpose, but honestly speaking, as researcher, and professor, I don't feel to find a different name for an already recognized and published protocol. I would like to discuss with all the scientific committee this point. But firstly, I ask to the author to clarify if the topic is referred only to the "All-on4" or also included different implant positions and numbers. For example, the presented clinical case (bu the presenter), in my opinion, didn't match the original All-on-4 protocol. Distal implants are tilted less then 30° degree. Higher cantilever distally is present. Implants are in line, so the A-P spread is not respected.

Finally, it is my personal opinion that, If we want a generic term to replace "All-on-4" we can't. If we want some terms to named full arch restorations, it depend by several factors. For example, screw- or cemented-retained, full- (or complete-) arch restoration is fine. This is in agreement with the Journal of prosthetic dentistry that published the Glossary of prosthodontic terms. I think scientific community should refer to these.[3] In addition, the name also depend by the type of the prosthesis. For example, I published a paper with the treatment of atrophic patients with 4 implants and removable prosthesis, and named it for implant overdenture.[4] Or, there are evidence to accept some terms proposed by prof. Avrampou, such as, hybrid, removable, etc. (always in agreement with the JPD).[5] Last but not the least, the classification of Misch (FP1, FP2, FP3, and RP) prostheses is well recognized, and actually most used.[6]

So, to conclude, the purpose of this topic must to be clarified, as well as, the way to reach the consensus.

[2]Davó, R., & David, L. (2019). Quad Zygoma: Technique and Realities. Oral and maxillofacial surgery clinics of North America, 31(2), 285–297. https://doi.org/10.1016/j.coms.2018.12.006

[3]The Glossary of Prosthodontic Terms. The Journal of Prosthetic Dentistry 117, e1–e105 (2017).

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[6]Misch CE. Dental Implant Prosthetics. 2nd ed. Amsterdam, Netherlands: Elsevier Health Sciences; 2014.

TOPIC Number 4 - Dr. Gaetano Noè

Title: Accuracy of 3D printed models in prosthodontics.
Presenter: Dr. Gaetano Noè

Background

There is controversial literature on the accuracy of 3D printed models in prosthodontics, and majority of the evidence comes from in-vitro research.

Methodology

The author proposed a Narrative Review.

1. Focused question has been reported: The focus question of the present review was to evaluate whether the accuracy of 3D printed models suitable for prosthodontic restorations, and whether there were any possible factors influencing their accuracy.
2. Search Strategy and Methods have been clearly reported in the presentation.
3. The inclusion and exclusion criteria have been clearly reported in the presentation.
4. Strengths and limitations of the evidence have been reported in the presentation, but not in agreement with the AGREE guidelines.
5. Basing on the collected data, the author (presenter) concluded with controversial evidence, so there is the need to reach a consensus, maybe to support further research, but first of all, to give some real guidelines for dentistry and dental technicians. The author proposed some questions to formulate guidelines, and to reach the consensus. The Audience can proposed different opinions and the AUDIENCE will discuss any disagreement with the aim to reach the consensus. Finally, dichotomy questions have been provided. Due to the AUDIENCE is composed by 10 members, the proposal is to give double vote to the Chair in case of parity (5 versus 5).

Grading of the evidence

The selected topic is not well recognized in the scientific literature. Results are controversial and most of the evidence (weak) comes from in-vitro research. So it is not easy to conduct a well designed review. However, for the same reasons, there is the need to discuss this crucial topic for prosthodontist, and to reach a consensus mostly based on clinical evidence.

Conclusions for the author

The author prepared a well design narrative review, in agreement with AGREE guidelines where possible. Level of evidence is sufficient for the purpose of this Global Consensus Meeting. The method to reach the consensus is valid. No further action are needed.

Questions to reach the consensus

Osstem Global Consensus Meeting

ACCURACY OF 3D PRINTED MODELS IN PROSTHODONTICS

Prof. Gaetano Noè

Are you agree with the result of the narrative review:

Accuracy of dental and industrial 3D printers is still controversial. There was found a bit trend to higher accuracy for conventional casts. Data comes from in vitro studies. Less accuracy was found for: More then three units to comple arch restorations (on natural teeth). Screw-retained restorations.

⭕ Yes
⭕ No
⭕ Propose other conclusions

2. Are you agree that high accuracy of IOSs and experience of the team (IOS technique) are crucial for the final accuracy of printed models?

⭕ Yes
⭕ No

3. Are you agree that the learning curve at both dentistry and dental technician level is crucial?

⭕ Yes
⭕ No

4 So, Are you agree that at Today, valuable precise models can be obtained only for single and up to three dental units restorations?

⭕ Yes
⭕ No
⭕ Propose different considerations

5. Are you agree that the best printing technologies are: MultiJet (industrial) DLP (office)

⭕ Yes
⭕ No
⭕ Propose different considerations

6. Are you agree that best model designs are: Hollowed model (for natural teeth), but with respect of minimum thick according to the used material, and full model for implant supported restorations.

⭕ Yes
⭕ No
⭕ Propose different considerations

7. Are you agree that acceptable value of accuracy should be: <50 microns (actually 100-200 microns)?

⭕ Yes
⭕ No
⭕ Propose different value

8. Are you agree that quality of resin materials and printers are crucial to obtain accurate precise models?

⭕ Yes
⭕ No
⭕ Propose different value

Dr. Gaetano Noè's results

All the authors (six plus the speaker) agreed with the first there points.

Regarding the question number 4: "Are you agree that at Today, valuable precise models can be obtained only for single and up to three dental units restorations?" Four authors plus the speaker agreed. Dr. Aguirre proposed the following consideration:

Accuracy of 3D printed models is highly variable in accuracy, depending on several factors. In 3-unit bridges, the accuracy of the model might not be enough to have passive fit when the bridge is design/constructed over the model. If the 3D-printed model is used only for finishing purposes and the bridge was constructed from the digital model within a CAD software, model's in-accuracy will not be relevant.

Also the speaker and prof. Tallarico agreed focusing on precision and positioning models.

Prof. KIM suggested to work model-free to obtain maximum accuracy. This is partially the same considering again precision and positioning models.

Question 4. There is no possibility to reach a strong consensus in this topic. Some notes will be proposed.

Regarding the accuracy of the printing machines, the speaker, dr. Uzgur and prof. Tallarico agreed to use Multijet in the lab (or service) and DLP in office. All the other professors (except prof. CHO that has not experience) also propose SLA.

Question 5. There is no possibility to reach a strong consensus in this topic. Some notes will be proposed.

Four authors plus the speaker agreed with question number 6. Dr. Aguirre also proposed hollow models for implants (Hollow models with 2 mm wall thickness). On the contrary, prof. EJ Kim supported that hollowed models may be acceptable for diagnostic models, He believe that a full filled solid model is superior in terms of accuracy, not only for working casts, but also for antagonist. Even if a note will be proposed, it is possibile to reach the consensus for the question 6.

All the authors agreed with the questions number 7 and 8. The consensus can be reached.

Dr. Aguiree add some comments from recent investigation to the discussion:

• Tan S, Tan MY, Wong KM, Maria R, Tan KBC. Comparison of 3D positional accuracy of implant analogs in printed resin models versus conventional stone casts: Effect of implant angulation. J Prosthodont. 2024 Jan;33(1):46-53. DOI: 10.1111/jopr.13647

Conclusions: With conventional stone casts, implant angulation had no significant effect on 3D linear and absolute angular distortions. Amongst printed resin models test groups, angulated implants had significantly greater ΔR. Amongst angulated implants tests groups, printed resin models had significantly greater ΔR than conventional stone casts. Compared to the master

model, all test groups, regardless of inter-implant angulation, produced greater inter-analog distances.

• Gagnon-Audet A, An H, Jensen UF, Bratos M, Sorensen JA. Trueness of 3-dimensionally printed complete arch implant analog casts. J Prosthet Dent. 2023 Aug 7:S0022-3913(23)00421-3. DOI: 10.1016/j.prosdent.2023.06.016

"Implant analog insertion errors were predominantly responsible for analog position 3D deviations rather than the polymerization shrinkage of additive photopolymers". Important operator-dependent factor.

One of the cited papers, Layal et al., stands "Even though there were 3D deviations between the master cast and all control and test casts generated from conventional impressions and digital scans respectively, the reference prosthesis presented with accurate fit on all casts. This indicates that there is a threshold for clinically acceptable accuracy of fit and that 3D-printed casts may be used as definitive master casts to fabricate implant-supported fixed dental prostheses for the partially edentulous anterior maxilla."

So… in summary, we go back to the passive fit threshold problem. I think that determining objectively and numerically the limit of linear and angular deviation of the prosthetic abutment against the implant (or analog), to generate strain, static load or separation (loss of passive fit). Some papers say that 200u deviation is acceptable, which is an exaggeration in my opinion, since 0.2mm is an evident misfit. When science manages to answer this question, we might be able to classify IOSs and 3D printers in terms of accuracy.

Consensus

Accuracy of 3D printed models in prosthodontics.

Material and methods. This study was conducted at the Department of Medicine, Surgery and Pharmacy, University of Sassari, Italy, between November 2023 and January 2024. In occasion of the "Osstem Global Consensus Meeting", 10 selected prosthodontics members proposed one or more toxic each. Within these, four topics were selected by the chairman and further discussed between participants, including the "Accuracy of 3D printed models in prosthodontics". The focus question of the present review was to evaluate whether the accuracy of 3D printed models suitable for prosthodontic restorations, and whether there were any possible factors influencing their accuracy.

A literature search strategy encompassing the literature in English published in the last five years, was performed to identify relevant studies meeting the inclusion criteria. The PubMed database of the U.S. National Library of Medicine has been consulted using a combination of Boolean keywords including MeSH (Medical Subject Headings), free text terms, and filters with the following combination: Search: (("prototype model*"[All Fields] OR (("digitalisation"[All Fields] OR "digitalised"[All Fields] OR "digitalization"[All Fields] OR "digitalize"[All Fields] OR "digitalized"[All Fields] OR "digitalizer"[All Fields] OR "digitalizing"[All Fields] OR "digitally"[All Fields] OR "digitals"[All Fields] OR "digitization"[All Fields] OR "digitizations"[All Fields] OR "digitize"[All Fields] OR "digitized"[All Fields] OR "digitizer"[All Fields] OR "digitizers"[All Fields] OR "digitizes"[All Fields] OR "digitizing"[All Fields] OR "radiographic image enhancement"[MeSH Terms] OR ("radiographic"[All Fields] AND "image"[All Fields] AND "enhancement"[All Fields]) OR "radiographic image enhancement"[All Fields] OR "digital"[All Fields]) AND "model*"[All Fields]) OR "3d printer"[All Fields]) AND ("accuracy"[All Fields] OR "Trueness"[All Fields] OR "precision"[All Fields]) AND ("dentistry"[All Fields] OR "prosthesis"[All Fields])) AND ((y_5[Filter]) AND (medline[Filter]) AND (fha[Filter]) AND (english[Filter])).

The following inclusion criteria was defined for the selection of the articles:
- Papers written in the English language;
- Papers reporting accuracy and or trueness of 3D printed models;
- Comparative studies (conventional stone models as control group); Single cohort studies reporting crucial informations to be used in this review; Prospective and retrospective observational studies.

Articles were excluded if they were: animal studies; reports with less than 8 samples/measurements for group.

Full-text papers were obtained for all the selected abstracts and titles that appeared to meet the inclusion and exclusion criteria, and they were assessed for inclusion by the same two reviewers. A final reviewer (MT) evaluated possible inconsistencies between the two reviewers. Moreover, the reference lists of the selected studies were screened for additional papers that could meet the eligibility criteria of this review. Given the narrative nature of this study, no any methodology and reporting quality of selected articles was performed in order to collect the greatest number of manuscripts. All the full texts of the selected papers were stored in shared folders accessible to all the reviewers.

Results. A total of 721 articles were found according to the search criteria. After title and abstracts evaluation, 57 articles were selected for full manuscript review. After reading the full text of all the selected papers, 9 manuscript deemed useful for the aim of the present narrative review.

Based on data from this narrative review, at Today, the accuracy of printed model allows to fabricate single or three-unit restorations with high level of accuracy. However, last generation of printers, as well as, learning curva is an important part of the process. In case of complex restorations, analog, or fully digital

work-flow are recommended. In the future, novel printing technologies, experiences, and new materials should allow to replace completely the conventional casts with digital printed models.

Title: Accuracy of 3D printed models in prosthodontics.

Presenter: Dr. Gaetano Noè

Global consensus

- Accuracy of dental and industrial 3D printers is still controversial. Data comes from in vitro studies suggested that there was a slightly trend to higher accuracy for conventional casts. Less accuracy was found for more then three units to comple arch restorations (on natural teeth) and screw-retained restorations.

- High accuracy of IOSs and experience of the team (IOS technique) are crucial for the final accuracy of printed models.

- Learning curve at both dentistry and dental technician level is crucial.

- Precise and positioning models should be considered as separate entities. Precise models are master models used to realize a prosthetic restoration (as alternative to free-model work flow); positioning models are used just to refine and finish a restoration.

- At Today, valuable precise models could be obtained only for single and up to three dental units restorations. However, several variabilities must to be considered, including, experience of the operators, calibration and the printing machines, quality of used resin, etc.

- Accuracy of 3D printed models is highly variable in accuracy, depending on several factors. In 3-unit bridges, the accuracy of the model (precise model) might not be enough to have passive fit when the bridge is design/constructed over the model. Working with a model-free workflow should be considered. If the 3D-printed model is used only for finishing purposes (positioning model) and the bridge was constructed from the digital model within a CAD software, model's in-accuracy will not be relevant.

- Best printing technologies are not enough. Several variabilities must to be considered.

- Hollowed models can be used for both natural teeth and implants, but with 2 mm wall thickness.

- Acceptable value of accuracy should be: <50 microns.

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- The cumulative effect of error in the digital workflow for complete-arch implant-supported frameworks: An in vitro study. Pan Y(1)(2), Tsoi JKH(2), Lam WYH(2), Zhao K(3), Pow EHN(2).

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TOPIC Number 5 - Prof. M. Tallarico

Title: What are the prosthetic triggers to reduce the risk of per-implantitis
Presenter: Prof. Marco Tallarico

Background

Peri-implant diseases have been classified as either peri-implant mucositis or peri-implantitis (Berglundh et al. 2002). Peri-implant mucositis has been defined as soft tissue inflammation around a functioning dental implant with bleeding on probing (BOP), and per-implantitis is distinguished by accompanying loss of supporting marginal bone past normal bone remodeling (Berglundh et al. 2002). If not diagnosed and not properly managed, peri-implant diseases may lead to loss of the implant (Mombelli et al. 2012).

Peri-implantitis is defined, in accordance with the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions, as: "a plaque-associated pathological condition occurring in tissues around dental implants, characterized by inflammation in the peri-implant mucosa and subsequent progressive loss of supporting bone" [3].

Mombelli et al. (1987) originally described peri-implant diseases as infectious diseases that shares features with chronic periodontitis. Currently, although the hypothesis of bacterial infection due to plaque accumulation as the etiological factor is still accepted, it appear to be a multifactorial disease, where so-called combined factors (patient-, surgical-, and prosthetic-related) may contribute to the development and severity of the pathosis (Canullo et al. 2016; Tallarico et al. 2018).

Methodology

The author proposed a Narrative Review, starting from two previous works on the same topic (Canullo et al. 2016; Tallarico et al. 2018).

1. Focused question has been reported: The focus question of the present review was to evaluate whether there are so-called combined factors (patient-, surgical-, and prosthetic-related) that may contribute to the development and severity of the pathology. Search Strategy and Methods have been clearly reported in the presentation.
2. The inclusion and exclusion criteria have been clearly reported in the presentation.
3. Strengths and limitations of the evidence have been reported in the presentation, but not in agreement with the AGREE guidelines.
4. Basing on the collected data, the author (presenter) concluded with controversial evidence, so there is the need to reach a consensus, maybe to support further research, but first of all, to give some real guidelines for dentistry. The author proposed some questions to formulate guidelines, and to reach the consensus. The Audience can proposed different opinions and the AUDIENCE will discuss any disagreement with the aim to reach the consensus. Finally, dichotomy questions have been provided.

Due to the AUDIENCE is composed by 10 members, the proposal is to give double vote to the Chair in case of parity (5 versus 5).

Grading of the evidence

The selected topic is not well recognized in the scientific literature. Results are controversial and most of the evidence (weak) comes from in-vitro research. So it is not easy to conduct a well designed review. However, for the same reasons, there is the need to discuss this crucial topic for prosthodontist, and to reach a consensus mostly based on clinical evidence.

Conclusions for the author

The author prepared a well design narrative review, in agreement with AGREE guidelines where possible. Level of evidence is sufficient for the purpose of this Global Consensus Meeting. The method to reach the consensus is valid. No further action are needed.

Questions to reach the consensus

Prof. Marco Tallarico

What are the prosthetic triggers to reduce the risk of per-implantitis

1 Are you agree that peri-implantitis should be considered as multi-factorial disease with an inflammatory background that occurs in both soft and hard tissues surrounding implants?

○ Yes
○ No
○ Other

2 Are you agree that Plaque induced, prosthetically and surgically triggered peri-implantitis are different entities associated with distinguishing predictive profiles and may contribute to marginal bone loss and secondary bacterial contamination?

○ Yes
○ No
○ Other

3 Are you agree that malpositioned implants is one of the most important "prosthetic" factor to potentially induce MBL and consequently, risk of peri-implantitis?

○ Yes
○ No
○ Other

4 Are you agree that excessive residual cement is an important "prosthetic" factor to potentially induce MBL and consequently, risk of peri-implantitis?

○ Yes
○ No
○ Other

5 Are you agree that "prosthetic problems" at the implant-abutment interface can lead to higher MBL and consequently risk of peri-implantitis?

○ Yes
○ No
○ Other

6 Are you agree that "prosthetic problems" (micromovements, microleakage, etc.) at the implant-abutment interface can lead to higher MBL and consequently risk of peri-implantitis?

○ Yes
○ No
○ Other

7 Are you agree that overloading (i.e. tilted implants, bruxism, cantilever, etc.) can lead to higher MBL and consequently risk of peri-implantitis?

○ Yes
○ No

○ Other

8 Are you agree that smokers and systemic conditions are co-factors in the developing of the peri-implant diseases, so that, in these patients, proper surgical and prosthetic protocols must to be considered?

○ Yes
○ No
○ Other

9 Are you agree that larger (>30°) emergence angle (EA) could be associated with a higher prevalence of peri-implantitis or marginal bone loss compared to a smaller EA (<30°).

○ Yes
○ No
○ Other

10 Are you agree that convex emergence profile could be associated with a higher prevalence of peri-implantitis or marginal bone loss compared to a flat EP?

○ Yes
○ No
○ Other

Prof. Marco Tallarico's results

Seven authors completed the sent form (Cho Young Jin, Jong-Eun Kim, Sooyoung Lee, Recep Uzgur, Okubo Chikahiro, Marco Tallarico, Gaetano Noè.

Expect for a couple of clarifications that have been accepted, all the authors agreed with the first 8 questions.

- Regarding questions number 9 and 10 there is a different position from Jong-Eun Kim:

10. Are you agree that convex emergence profile could be associated with a higher prevalence of peri-implantitis or marginal bone loss compared to a flat EP?

Answer: I'll need to check where the convex regions are. I don't think convex appearance profiles cause problems in critical contour regions, but they can sometimes cause problems in subcritical contour regions according to the implant position.

The question could be modified accordingly:

10 Are you agree that, according to the implant position and quality/quantity of hard and soft tissues, convex emergence profile at the subcritical contour could be associated with a higher marginal bone loss compared to a flat EP, and so that, higher risk of peri-implantitis?

9. Are you agree that convex emergence profile could be associated with a higher prevalence of peri-implantitis or marginal bone loss compared to a flat EP?

I think proper amount of convex emergence profile on coronal part of gingiva is Ok, But convex form on apical part can cause MBL compared to a flat EP.

The question could be modified accordingly:

9. Are you agree that convex emergence profile at the subcritical contour could be associated with a higher prevalence of peri-implantitis or marginal bone loss compared to a flat EP?

- Okubo Chikahiro at the question 10 asked the follow:

Are you agree that larger (>30°) emergence angle (EA) could be associated with a higher prevalence of peri-implantitis or marginal bone loss compared to a smaller EA (<30°).

I agree, however, it is unclear whether 30 degrees is the boundary value. I think this value could be evaluate in the next topic (design of the abutment).

Title: What are the prosthetic triggers to reduce the risk of per-implantitis
Presenter: Prof. Marco Tallarico

Global consensus

Material and methods. This study was conducted at the Department of Medicine, Surgery and Pharmacy, University of Sassari, Italy, between November 2023 and January 2024. In occasion of the "Osstem Global Consensus Meeting", 10 selected prosthodontics members proposed one or more toxic each. Within these, four topics were selected by the chairman and further discussed between participants, including the "Accuracy of 3D printed models in prosthodontics". The focus question of the present review was to evaluate whether there are so-called combined factors (patient-, surgical-, and prosthetic-related) that may contribute to the development and severity of the pathology. Search Strategy and Methods have been clearly reported in the presentation.

Peri-implantitis should be considered as multi-factorial disease with an inflammatory background that occurs in both soft and hard tissues surrounding implants.

Plaque induced, prosthetically and surgically triggered peri-implantitis are different entities associated with distinguishing predictive profiles and may contribute to marginal bone loss and secondary bacterial contamination.

Malpositioned implants is one of the most important "prosthetic" factor to potentially induce MBL and consequently, risk of peri-implantitis?

Excessive residual cement is an important "prosthetic" factor to potentially induce MBL and consequently, risk of peri-implantitis?

"Prosthetic problems" at the implant-abutment interface can lead to higher MBL and consequently risk of peri-implantitis.

"Prosthetic problems" (micromovements, microleakage, etc.) at the implant-abutment interface can lead to higher MBL and consequently risk of peri-implantitis?

Overloading (i.e. tilted implants, bruxism, cantilever, etc.) can lead to higher MBL and consequently risk of peri-implantitis?

Smokers and systemic conditions are co-factors in the developing of the peri-implant diseases, so that, in these patients, proper surgical and prosthetic protocols must to be considered?

According to the implant position and quality/quantity of hard and soft tissues, convex emergence profile at the subcritical contour could be associated with a higher marginal bone loss compared to a flat EP, and so that, higher risk of peri-implantitis.

Convex emergence profile could be associated with a higher prevalence of peri-implantitis or marginal bone loss compared to a flat EP.

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AGREE Approach (Yes or NOT)

	FOCUSED/PICO	Search Strategy	Indirectness of Evidence	Strength and limitations	How to reach the consensus
Tallarico Marco	YES	YES	YES	YES	YES
Aguirre Felipe	NOT CLEAR	NO	NO	NO	NO
Kwantae Noh	NOT CLEAR	NO	NO	NO	NO
Gaetano Noè	YES	YES	YES	Not Clear	YES

GRADE APPROACH (from A to D)

	Methodology limitations	Inconsistency of the results	Criteria	Imprecision of the results	Publications Bias	Factor that can RAISE
Tallarico M.	C	B	A	B	B	B
Aguirre F.	N/A	N/A	N/A	N/A	N/A	N/A
Kwantae Noh	N/A	N/A	N/A	N/A	N/A	N/A
Gaetano Noè	C	B	A	B	C	N/A

N/A Not applicable

General conclusions

At the first round, only 2 out of 4 presenters fully satisfied the suggested (by the Chair) criteria. Suggested criteria are the AGREE guidelines for the review process, and the GRADE system for the quality of the works, including the way to reach the consensus. Global Consensus Meeting have to provide useful and strong guidelines for dentistry, based on available scientific evidence, and clinical considerations. Osstem is the third brand in the word, and the most sold implant in the world. Osstem should provide strong and evidence-based guidelines for their users. Moreover, Osstem is in competition with 1st and 2nd brand in the world, respectively, Straumann and Nobel Biocare, that can count of very well recognized and scientifically oriented scientific community (ITI and FOR). So, I agree with the reviews of prof. Tallarico Marco and Gaetano Noè that, even in a very short time, match with the suggested criteria, and allow the AUDIENCE to find a consensus and to provide strong, evidence-based, conclusions (consensus, guidelines) to be published in further papers. Dr. Aguirre, and prof. Kwantae, even if did a good and appreciated work, failed to follow the suggestion guidelines. So, it is not easy, or not possible to reach a strong and evidence-based consensus. The risk is to provide personal opinion that can not be used globally. So I invited the presenter to review their works. In alternative, their works can be used as background for further considerations. For example, the presentation of dr. Aguirre highlight the needs for Osstem Implant to develop revers scan. So I invited the dr. Aguirre to review his work, try to make it more scientifically oriented, and also to find the way to reach the consent. I think all the audience agree that, eve if there is no strong evidence, revers scan should be developed by Osstem, due to they seems to be the most accurate standby design. Regarding the topic of prof. Kwantae Noh, it is not easy to find a consensus in a very short time, and in a complicated, and sensitive topic. However, the question is: do we need to change the terminology? Why? Why we can not use the Terms suggested by the JPD?

At the **second Round**, dr. Felipe Aguirre sent in advance the form with the questions to reach the consensus. Same for Prof. M. Tallarico and prof. G. Noè. Basically, in the second round has been discussed the first three topics (Tallarico, Noè, Aguirre) and reached the consensus with some notes. Prof. Tallarico will send the draft of the consensus for double check, asking to dr. Felipe particularly attention for the digital topics. In addition, Prof. Tallarico presented new topic about triggers factors for peri-implantitis. He will send the form with the questions to reach the consensus and the PDF with the slides. Moreover, some papers will be send as requested from some attended. A new interesting topic could be suggested for next GCM: Impact of abutment design and materials on the peri-implant soft and hard tissues. In the third round (face to face) it will be possible to finalize the consensus for 4 out of 5 topics. Topic number 3 will be discussed face to face in Seoul.

Abutment Materials for gingival health

After explanation of this topic and the analysis of several manuscript from the international literature, the conclusions are the follow:

1. Material Characteristics
Titanium and zirconia are demonstrating similar performance in terms of biological response and mechanical properties. According to these studies, both materials show comparable responses in soft tissue over a clinical period of more than five years, with zirconia achieving superior aesthetic outcomes.

2. T-base Cementation and Gap Issues
In hybrid abutments, the cement (related to the gap at the interface) could cause inflammation in the surrounding soft tissue, however, within the clinically acceptable range. Reducing the cement gap and performing the cementation outside the patient's mouth are important for maintaining soft tissue health.

3. Surface Treatment of the Material
Many studies indicate that the surface treatment of titanium and zirconia abutments does not significantly affect inflammatory responses. While the long-term effects of surface treatment are still under discussion, certain treatments like TiN coating have shown positive results in terms of biocompatibility and aesthetics.

1. Do you agree that titanium is the best material for the implant abutment?

○ Yes
○ No
○ Other

2. Do you agree that Zirconia hybrid abutment can replace titanium abutment for not only for anterior but also posterior area?

○ Yes
○ No
○ Other

3. Do you agree that the cement or micro-gap do not affect the gingival health?

○ Yes
○ No
○ Other

4. Do you agree that location of joint for hybrid abutment does not affect the gingival health?

○ Yes
○ No
○ Other

1. Do you agree that Surface treatment of abutment can affect the gingival health?

○ Yes

○ No
○ Other

Results

All the attendees agree with the proposal questions with some clarification. Considering the point 2 "Zirconia hybrid abutment can replace titanium abutment" both Titanium and Zirconia can be considered the gold standard materials for implant rehabilitations. However, Zirconia must to be bonded on Titanium Link (Hybrid). Cement at micro-gap do not affect the gingival health, however, cementation must to be performed chairside (out of the patient mouth) and well refined. Surface treatment on zirconia are not necessary. Maybe could be on titanium.

About question number 4 (Do you agree that location of joint for hybrid abutment does not affect the gingival health?), it deserve more discussion, maybe together with next topic (Abutment design).

Further suggestions

1. Presentation of draft consensus statement in a plenary session during OWM.
2. Publication of the results in peer reviewed journals and OIC book.
3. On-Line meeting with global representers of different OIC community across the globe with the specific aim to share the results of this Global Consensus Meeting, but firstly to think at one Global Scientific Community.
4. Start to officially collect members of the OIC in order to have a real competition with other scientific community across the globe, such us ITI (International Team for Implantology), sponsored by Straumann, that have about 20.000 members in the entire globe. As Osstem is the most sold implant, Osstem is potentially the biggest community in the world. The vision of Osstem Company to become the implant number 1 (not only the most sold implant) should be agreed by the Scientific Community that should have the vision to become the biggest community in the world.
5. Last but not the least, with more then 20.000 potential members, considering a membership fee of 100 euros for the first yeas, Scientific Community should have 2.000.000 million of Euros to improve research and teaching activities for the benefit of Osstem Users. In addition, changing the vision of OIC to a more globally oriented and scientifically oriented community, we can attract not Osstem Users having several commercial and marketing benefits.
6. Finally, in order to promote OIC as one of the best and biggest scientific community in the world, the name should be changed. Osstem is a commercial name. Having a commercial brand in the name, allow the scientific community to be commercially oriented and not scientifically oriented, with several negative points. Suggestion from OIC Europe is to move from Osstem Implant Community to Oral Implant Community, maintaining the OIC as basic name.

DIGITAL DIVISION

Indice

Variations in the physical and chemical properties of surgical guides post-cured with different post-curing units

Prof. Dr. Luis De Bellis

Clinical Insights

The functionality of digital dental fabrication technologies including 3-dimensional (3D) printing continues to expand. Compared with conventional and subtractive manufacturing methods, 3D printing can minimize material waste, reduce manufacturing time, and produce complex morphologies.[1-3]

Market penetration of 3D polymer printers in dental practices is growing. Of the 17% of respondents who indicated they were users, 67% had been doing so for 2 years or less. Of the 83% without a 3D printer, 21% indicated that they were planning to purchase or rent one in 2023. Regarding implications on practice infrastructure, hiring new or training existing clinical staff members (61%) and changes to the interactions with an external laboratory (51%) were common.

Almost one-half (48%) of those using 3D printing reported doing so in at least 25% of cases requiring the fabrication of a model or appliance. Reported advantages included improved efficiency (68%), reduced costs (44%), better outcomes (20%), improved patient communications (20%), and reduced chair time (20%). The more frequently reported clinical applications were diagnostic models (62%), splints and occlusal devices (50%), and surgical guides (48%). Less common were fabrication of complete dentures (14%), definitive fixed restorations (12%), and partial dentures (5%). We speculate this may reflect material availability, printing development, and mechanical properties of the printed materials.[4,5]

Among the nonusers (83%), the most common reasons for not having a printer were reliance on dental laboratories for clinical devices (44%), required financial investment (39%), and types of cases treated (34%). With continued 3D printing technological development, application expansion, and material science innovation, it is likely the use of additive manufacturing devices will become increasingly common in practice. Dentists who are thinking of adding a 3D printer to their practice should monitor these developments and consider whether the practical uses fit their needs.

QUESTION

How would different post-processing methods affect physical, chemical and dimensional properties of surgical guide materials?

Research Protocol

Systematic electronic literature search conducted in Ovid Medline via OVID, Scopus, PUBMed, Scielo and Web of Science. The search will limited to full text in English, Spanish and Portuguese language using filters like META ANALYSIS, REVIEW, SYSTEMATIC REVIEW from 2021 to 2024.

Prof. Dr. Luis De Bellis

Effect of 3D printing system and post-curing atmosphere on micro- and nano-wear of additive-manufactured occlusal splint materials

Junichiro Wada [a,b,*], Kanae Wada [a,c], Sufyan Garoushi [a], Akikazu Shinya [a,d], Noriyuki Wakabayashi [b], Tsutomu Iwamoto [c], Pekka K. Vallittu [a,e], Lippo Lassila [a]

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Article

Effect of 3D Printer Type and Use of Protection Gas during Post-Curing on Some Physical Properties of Soft Occlusal Splint Material

Junichiro Wada [1,2,*], Kanae Wada [1,3], Mona Gibreel [1], Noriyuki Wakabayashi [2], Tsutomu Iwamoto [3], Pekka K. Vallittu [1,4] and Lippo Lassila [1,*]

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Influence of different post-processing methods on the dimensional accuracy of 3D-printed photopolymers for dental crown applications - A systematic review

Jason Cao [a], Xiaoyun Liu [a], Andrew Cameron [b,c], John Aarts [a], Joanne Jung Eun Choi [a,*]

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Prof. Dr. Luis De Bellis

Influence of Post-Processing on the Degree of Conversion and Mechanical Properties of 3D-Printed Polyurethane Aligners

Luka Šimunović [1] [iD], Antonija Jurela [2], Karlo Sudarević [2], Ivana Bačić [3] [iD], Tatjana Haramina [4] and Senka Meštrović [1,*] [iD]

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Additive Manufacturing Post-Processing Treatments, a Review with Emphasis on Mechanical Characteristics

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RESEARCH AND EDUCATION

Comparing the mechanical properties of pressed, milled, and 3D-printed resins for occlusal devices

Constantin Berli, med dent,[a] Florian M. Thieringer, Dr med Dr med dent,[b] Neha Sharma, Dr med dent,[c] Johannes A. Müller, Dr med dent,[d] Philipp Dedem, Dr med dent,[e] Jens Fischer, Prof, Dr med dent, Dr rer nat,[f] and Nadja Rohr, Dr med dent[g]

Given the limited information available on resin printing for surgical guides, it is necessary to modify the title of my issue, replacing the word "surgical guides" with "devices"

Variations in the physical and chemical properties of 3D PRINTED DEVICES post-cured with different post-curing units

Effect of 3D printing system and post-curing atmosphere on micro- and nano-wear of additive-manufactured occlusal splint materials

Junichiro Wada [a,b,*], Kanae Wada [a,c], Sufyan Garoushi [a], Akikazu Shinya [a,d], Noriyuki Wakabayashi [b], Tsutomu Iwamoto [c], Pekka K. Vallittu [a,e], Lippo Lassila [a]
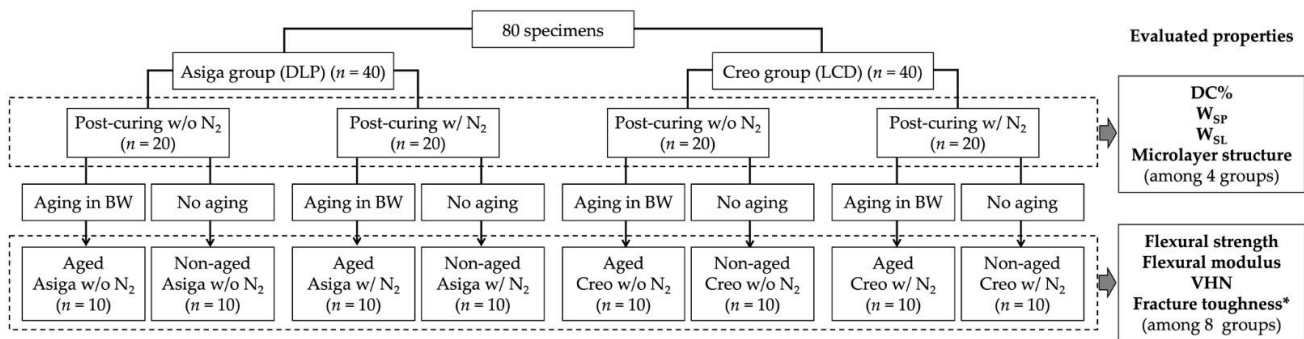
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Both the printing system and post-curing at- mosphere significantly affected all the evaluated properties ($p < 0.05$). The specimens additive-manufactured by DLP printer tended to show higher wear resistance in the hard material groups and lower wear resistance in the soft material groups when compared to those by LCD printer. The post-curing at N2 atmosphere significantly enhanced the microwear resistance of hard material groups additive-manufactured by the DLP printer ($p < 0.05$) and soft material groups additive-manufactured by the LCD printer ($p < 0.01$), while it significantly enhanced the nano-wear resistance of both hard and soft material groups regardless of the printing system

It can be concluded that 3D printing system and post-curing atmosphere affect the micro- and nano-wear resistance of tested additively manufactured OS materials. In addition, it can be also concluded that the optical printing system providing higher wear resistance depends on the material type, and using nitrogen gas as a protection gas during post-curing enhances the wear resistance of tested materials.

Effect of 3D Printer Type and Use of Protection Gas during Post-Curing on Some Physical Properties of Soft Occlusal Splint Material

Junichiro Wada [1,2,*] , Kanae Wada [1,3], Mona Gibreel [1], Noriyuki Wakabayashi [2], Tsutomu Iwamoto [3], Pekka K. Vallittu [1,4] and Lippo Lassila [1,*]

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The printer type significantly affected all the evaluated properties. Flexural strength, flexural modulus, and fracture toughness were significantly higher when specimens were printed by a DLP printer, while VHN and DC% were significantly higher, and a smoother surface was noticeably obtained when printed by an LCD printer. **The post-curing at an N2 atmosphere significantly enhanced all of the evaluated properties except water sorption**, 3D microlayer structure, and fracture toughness. The current results suggested that the printer type and the post-curing methods would have an impact on the mechanical and surface properties of the evaluated material.

Influence of different post-processing methods on the dimensional accuracy of 3D-printed photopolymers for dental crown applications - A systematic review

Jason Cao [a], Xiaoyun Liu [a], Andrew Cameron [b,c], John Aarts [a], Joanne Jung Eun Choi [a,*]

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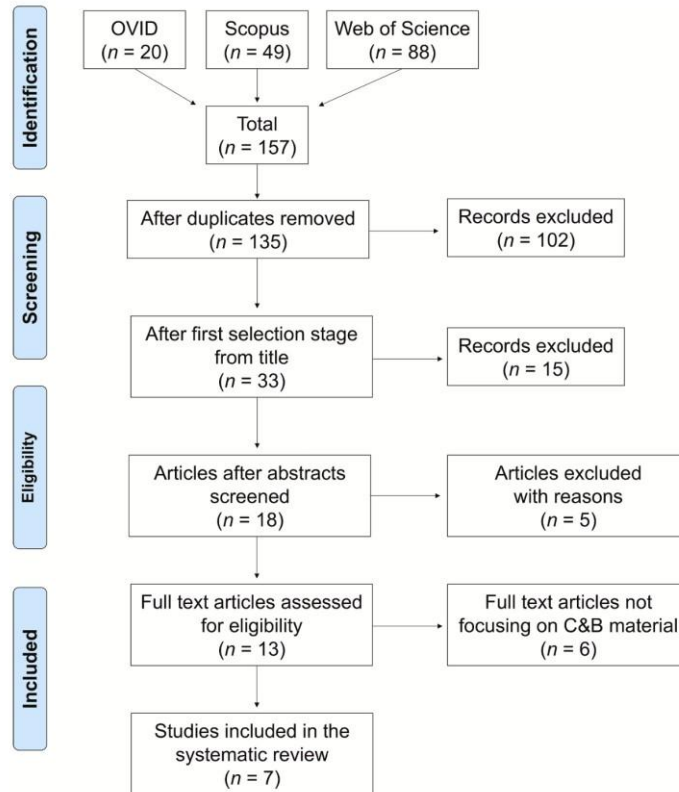
Within the limitations of this review, following conclusions were made.

1.1) Post-processing washing times outside the prescribed IFU may have an impact on the physical and biocompatibility characteristics of the material.

2.2) Studies focusing on inert mediums during post-processing require more detailed investigation.

3.3) The use of different post-curing conditions does not significantly affect the materials dimensional accuracy.

4.4) More standardised methodologies for analysing data should be implemented and ± ve values should be used alongside RMS/RMSE values.

Influence of Post-Processing on the Degree of Conversion and Mechanical Properties of 3D-Printed Polyurethane Aligners

Luka Šimunović [1] , **Antonija Jurela** [2], **Karlo Sudarević** [2], **Ivana Bačić** [3] , **Tatjana Haramina** [4] **and Senka Meštrović** [1,*]

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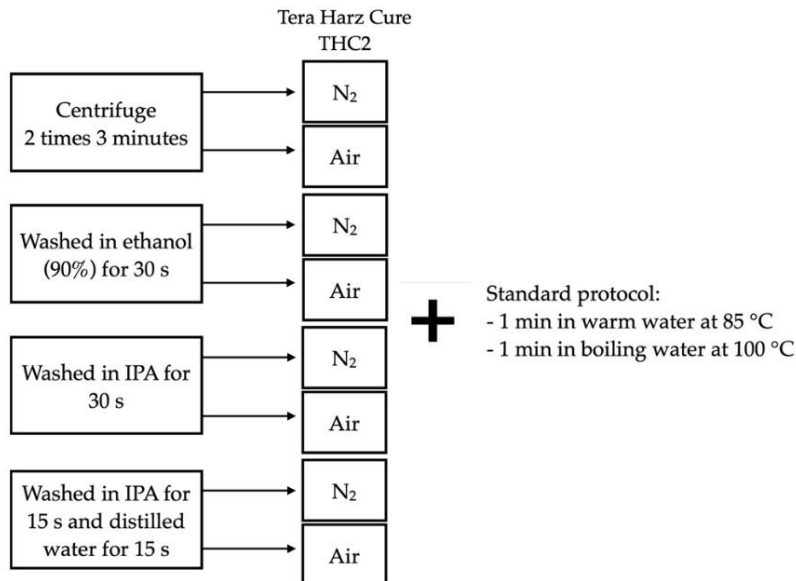
A study by Jung-Hwa et al. has detailed how oxygen, particularly in ambient air, can interfere with the curing process of photopolymer resins, leading to incomplete polymerization and compromised material properties

various strategies have been investigated to mitigate oxygen inhibition, including the use of inert atmospheres during curing and the development of oxygen-scavenging additives [62,63]. These ap- proaches aim to enhance the degree of conversion and mechanical properties of the resin, a goal echoed in newer studies that examined the effects of reduced oxygen environments on the tensile strength and surface roughness of 3d-printed objects

Ethanol might interact with the resin matrix in a manner that promotes better cross-linking when devoid of oxygen

Subsequent polymerization in a nitrogen environment ensures that the material is not exposed to oxygen, which, as previously discussed, can act as an inhibitor to the polymerization process

The significantly higher hardness values in groups rinsed with IPA and IPAW can be associated with the solvent's characteristics. IPA is known to be a more aggressive solvent compared to ethanol [33], potentially leading to a more extensive removal of uncured resin and potentially aiding in better cross-linking within the material during polymerization This could result in a denser material, contributing to the increased hardness which was observed.

The detrimental impact of oxygen on the polymerization process was clearly demon- strated, underscoring the necessity of an oxygen-devoid environment for obtaining optimal material properties

Additive Manufacturing Post-Processing Treatments, a Review with Emphasis on Mechanical Characteristics

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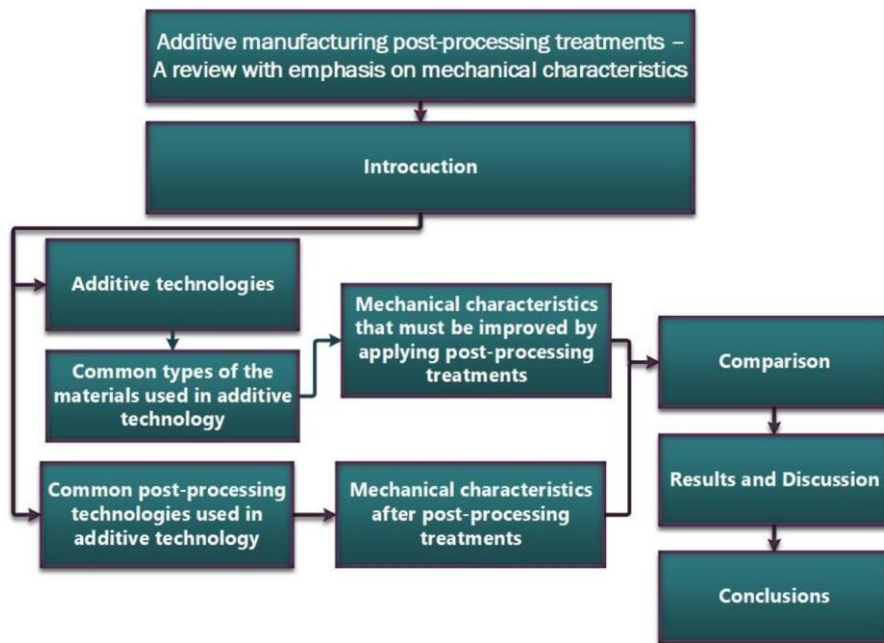
By carefully controlling the heat treatment process parameters, the properties of additive manufactured parts can be optimized to meet the requirements of the applications for which they are intended

Post-processing treatments can be used strategically to modify the mechanical properties of 3D-printed parts in order to meet desired performance requirements.

However, thorough testing and evaluation of the mechanical properties under different conditions are necessary to ensure the reliability and performance of the final printed parts. Further research and experimentation are needed to better understand the effects of post-processing heat treatment on tensile properties and to develop optimized heat treatment strategies for specific 3D printing materials and applications.

Comparing the mechanical properties of pressed, milled, and 3D-printed resins for occlusal devices

Constantin Berli, med dent,[a] Florian M. Thieringer, Dr med Dr med dent,[b] Neha Sharma, Dr med dent,[c] Johannes A. Müller, Dr med dent,[d] Philipp Dedem, Dr med dent,[e] Jens Fischer, Prof, Dr med dent, Dr rer nat,[f] and Nadja Rohr, Dr med dent[g]

Table 1. Type, code, name, and manufacturer of tested resin materials for occlusal devices

Type	Code	Name	Manufacturer
Pressed	cPB	ProBase Cold	Ivoclar Vivadent AG
	cPP	Palapress clear	Kulzer GmbH
	cAB	Aesthetic Blue clear	Candulor
Milled	sTP	Temp Premium Flexible Transpa	Zirkonzahn
	sIP	idodentine PMMA transparent	Unión Dental S.A
	sYP	Yamahachi PMMA clear	Yamahachi Dental MFG
3D-printed	aFS	Freeprint splint	DETAX GmbH
	aLP	LuxaPrint Ortho Plus	DMG GmbH
	aNO	Nextdent Ortho Clear	Vertex-Dental B.V.
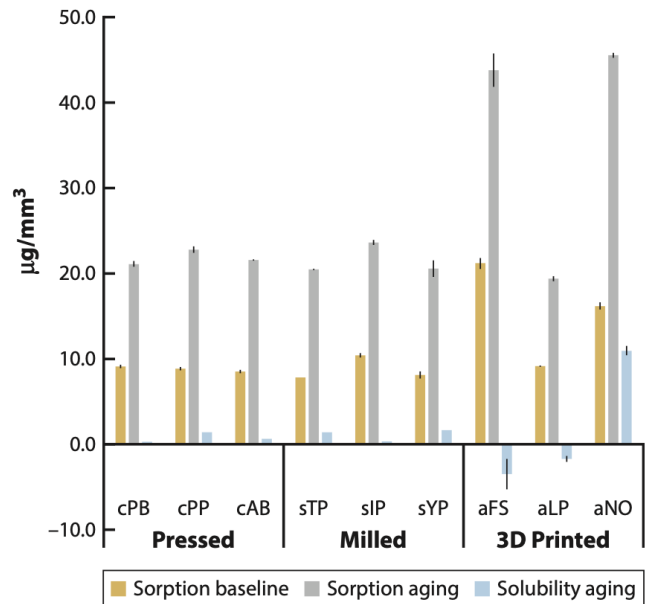
After the printing process, the specimens were cleaned with 90% isopropyl alcohol for 5 minutes according to the manufacturer's specifications and poly- merized from all sides for 20 minutes by using ultraviolet light (385 nm) with a UV-A type 3 postpolymerization lightbox (type E0202; Yizhet).

Conclusion; Relative to the pressed and milled resins, the 3D-printed resins had lower flexural strength and hardness values and higher water sorption and solubility.

ISSUE: Should we expect variations in the Accuracy and Mechanical properties of 3D PRINTED DEVICES that are post-cured with different post-curing units?

CONSENSUS: The current evidence shows that different protocols and substances used, such as isopropyl alcohol for washing parts produced by 3D printing, will directly affect the accuracy and mechanical properties of the produced devices, just as different technologies of post-curing units can, which may include LEDs of different wavelengths, temperature control in the post-curing chamber, and the use or production of nitrogen, beyond the technology and resin used for 3D printing

REFERENCE:

Effect of 3D printing system and post-curing atmosphere on micro- and nano-wear of additive-manufactured occlusal splint materials Junichiro Wada a,b,*, Kanae Wada a,c, Sufyan Garoushi a, Akikazu Shinya a,d, Noriyuki Wakabayashi b, Tsutomu Iwamoto c, Pekka K. Vallittu a, e, Lippo Lassila a

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Issue 1

Are the auxiliary devices effective for the accuracy of intraoral scanning for complete fixed prostheses when using cylinder-type scan bodies?

Consensus

For the intraoral scanning for complete fixed prostheses, auxiliary devices are recommended to path the scan bodies.

Pathing the scan bodies with the flat-shaped auxiliary devices near the mucosa could help to gain an accurate impression of intraoral scanning.

作図例
Wu HK et al. Effect of artificial landmarks of the prefabricated auxiliary devices located at different arch positions on the accuracy of complete-arch edentulous digital implant scanning: An in-vitro study.より拝借

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Prof. Manabu Kanazawa

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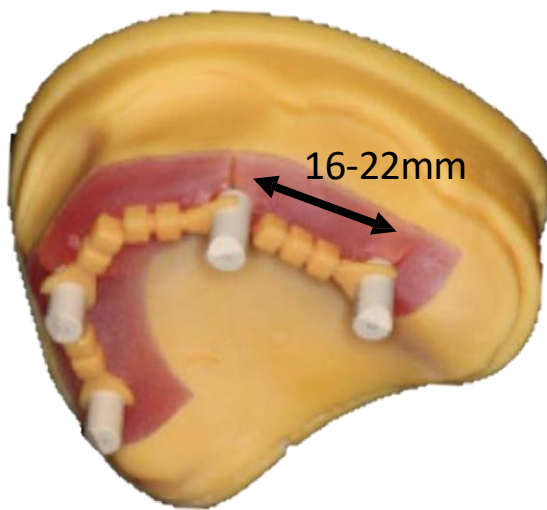
Issue 2

How much inter-implant distance is acceptable to gain an accurate impression using an intraoral scanner for complete fixed prostheses?

Consensus

The position of the implant had a significant effect on trueness.

16-22mm of inter-implant distance is acceptable to gain an accurate impression using an intraoral scanner for complete fixed prostheses.

16-22mm

作図例
Wu HK et al. Effect of artificial landmarks of the prefabricated auxiliary devices located at different arch positions on the accuracy of complete-arch edentulous digital implant scanning: An in-vitro study.より拝借
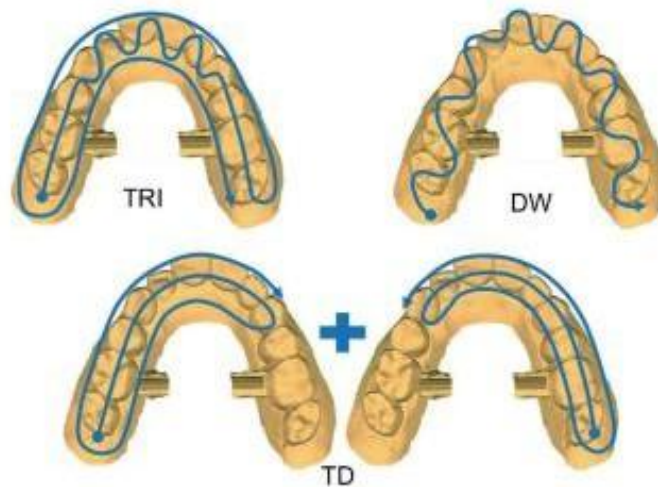
Reference

Prof. Manabu Kanazawa

1. Carneiro Pereira AL, Souza Curinga MR, Melo Segundo HV, da Fonte Porto Carreiro A. Factors that influence the accuracy of intraoral scanning of total edentulous arches rehabilitated with multiple implants: A systematic review. J Prosthet Dent. 2023 Jun;129(6):855-862.

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3. Mizumoto RM, Alp G, Özcan M, Yilmaz B. The effect of scanning the palate and scan body position on the accuracy of complete-arch implant scans. Clin Implant Dent Relat Res. 2019 Oct;21(5):987-994.

4. Braian M, Wennerberg A. Trueness and precision of 5 intraoral scanners for scanning edentulous and dentate complete-arch mandibular casts: A comparative in vitro study. J Prosthet Dent. 2019 Aug;122(2):129-136.e2

Issue

Does the scanning pattern affect the accuracy of scan using iOS for implant?

Consensus

The scanning pattern affects the accuracy of intraoral digital scans. Therefore, it is generally recommended to follow the scanning pattern recommended by the respective IOS manufacturer.

Fig. 2. Different scan patterns of the three scanners: TRI = TRIOS 3; DW = Dental Wings, TD = True Definition.

Reference   **Presented by Dr Harry HK Shin**

Revilla-León M, Kois DE, Kois JC. A guide for maximizing the accuracy of intraoral digital scans. Part 1: Operator factors. J Esthet Restor Dent. 2023 Jan;35(1):230-240. doi: 10.1111/jerd.12985. Epub 2022 Dec 7. PMID: 36479807.

Pattamavilai S, Ongthiemsak C. Accuracy of intraoral scanners in different complete arch scan patterns. J Prosthet Dent. 2024 Jan;131(1):155-162.

Kaewbuasa N, Ongthiemsak C. Effect of different arch widths on the accuracy of three intraoral scanners. J Adv Prosthodont. 2021 Aug;13(4):205-215

Issue

Does ambient lighting conditions affect the accuracy of scan using iOS for implant?

Consensus

Ambient lighting conditions are one of the factors that significantly affect the scanning accuracy of IOS. It is important to follow the manufacturer's recommendations because there are no universally optimal lighting conditions that will maximize the accuracy of IOS. Most IOS perform better in 1000lux ambient illumination conditions, also known as indoor lighting conditions.

Therefore, the illuminance of the operative field suitable for digital scan was the ambient lighting condition requires turning off the dental chair light while leaving the room ceiling light on, and yellow or orange appeared to be the most suitable.

TABLE 2 Recommended ambient lighting condition based on the IOS system selected for acquiring intraoral digital scans.

Intraoral scanner; Manufacturer	Optimal ambient lighting conditions in dentate conditions	Optimal ambient lighting conditions digitizing implant scan bodies
Adva; GC America	1000 or 5000 Lux[39]	NA
CS 3600; Carestream	5000 Lux[39]	500 Lux[41]
CS 3700; Carestream	NA	100 Lux[41]
Emerald; Planmeca	Very inconsistent[39]	
i500; Medit	1000 Lux[40]	1000 Lux[41]
iTero Element; Align technologies	1000 Lux[34]	NA
iTero Element 5D; Align technologies	NA	100 Lux[41]
Omnicam; Dentsply Sirona	0 Lux[34] or 100 Lux[39]	NA
PrimeScan; Dentsply Sirona	NA	10,000 Lux[41]
Trios 3; 3Shape A/S	1000 Lux[34]	100 Lux[41]
Trios 4; 3Shape A/S	1000 Lux[34]	NA

Abbreviations: IOS, intraoral scanner; NA, not available.

Table 1
Evaluation of trueness.

Illuminance	Color temperature							
	3900 K		4100 K		7500 K		19,000 K	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
0 lux	62.3[A]	0.35	62.3[A]	0.35	62.3[A]	0.35	62.3[A]	0.35
500 lux	59.8[B]	0.51	61.7[AB]	0.17	61.9[AB]	0.61	62.0[AB]	0.61
2500 lux	63.8[A]	0.75	63.6[A]	0.68	62.7[A]	0.37	62.8[A]	0.15

Trueness is evaluated by superimposing the experimental data onto the master data and calculating the mean deviation (μm) between the corresponding points of the two data values in each test group ($n = 5$). Groups having the same superscript letter are not significantly different ($p > 0.05$). SD, standard deviation.

Reference   **Presented by Dr Harry HK Shin**

Arakida T, Kanazawa M, Iwaki M, Suzuki T, Minakuchi S. Evaluating the influence of ambient light on scanning trueness, precision, and time of intra oral scanner. J Prosthodont Res. 2018 Jul;62(3):324-329.

Revilla-León M, Kois DE, Kois JC. A guide for maximizing the accuracy of intraoral digital scans. Part 1: Operator factors. J Esthet Restor Dent. 2023 Jan;35(1):230-240. doi: 10.1111/jerd.12985. Epub 2022 Dec 7. PMID: 36479807.
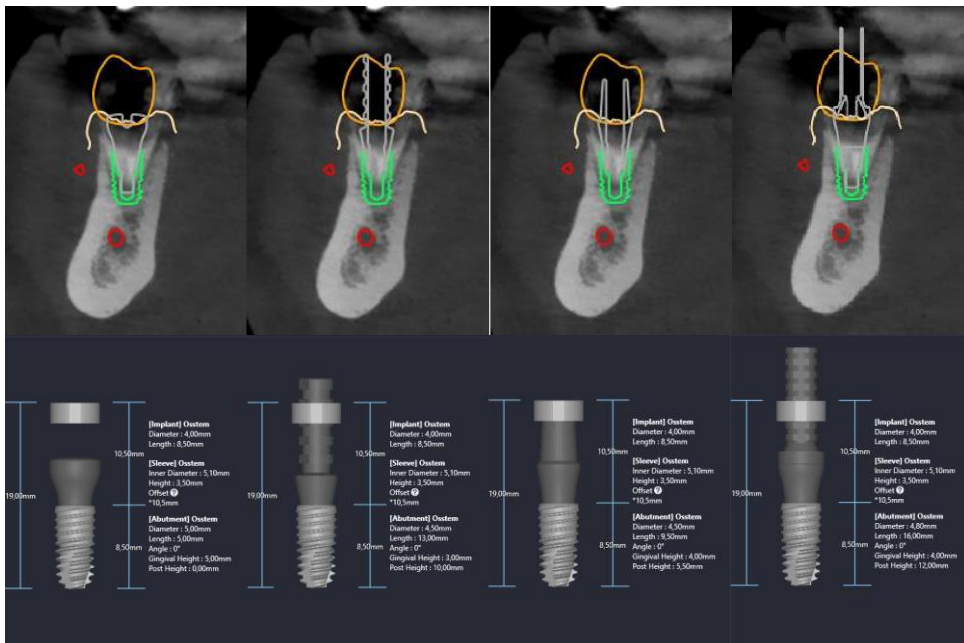
Issue

How to prevent clinical complications already during virtual planning of implant surgeries.

Consensus

Choose planning software with well-developed virtual library. Besides the diameter of the implant suggested for the particular site, use either healing abutment, temporary abutment, MUA or final abutment with gingival height not less than 4mm and emergence angle less than 30- 40° to position implant accordingly to the planned prosthetic reconstruction and provide optimal conditions to create healthy tissues of Implant Supracrestal Complex and prevent periimplantitis already at the planning stage.

Reference   **Presented by Dr. Łukasz Zadrożny**

- Rungtanakiat P, Thitaphanich N, Chengprapakorn W, Janda M, Arksornnukit M, Mattheos N. Association of prosthetic angles of the Implant Supracrestal Complex with peri-implant tissue mucositis. Clin Exp Dent Res. 2023 Jun;9(3):425-436. doi: 10.1002/cre2.750. Epub 2023 May 17. PMID: 37199078; PMCID: PMC10280616.
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- Mattheos N, Janda M, Acharya A, Pekarski S, Larsson C. Impact of design elements of the implant supracrestal complex (ISC) on the risk of peri-implant mucositis and peri-implantitis: A critical review. Clin Oral Implants Res. 2021 Oct;32 Suppl 21:181-202. doi: 10.1111/clr.13823. PMID: 34642979.
- Souza AB, Alshihri A, Kämmerer PW, Araújo MG, Gallucci GO. Histological and micro-CT analysis of peri-implant soft and hard tissue healing on implants with different healing abutments configurations. Clin Oral Implants Res. 2018 Oct;29(10):1007-1015. doi: 10.1111/clr.13367. Epub 2018 Sep 23. PMID: 30246409.
- Osstem Implant Consensus Reports: 2021/1; 2021/2; 2022; 2023.

Issue: Implant full arch rehabilitation using the complete digital workflow

How to verify the vertical dimension and record jaw relation in digital works?

Consensus

Conventional jaw relation record method using existed dentures or occlusal rim and trial denture bases is still common procedure even for digitally generated full mouth implant restorations. However, a new digital method using a scanner and specially designed devices for recording edentulous jaw relations digitally without occlusal bases can be available in digital dentistry recently. More studies should be conducted to establish the consensus of reliable new digital jaw relation record techniques.
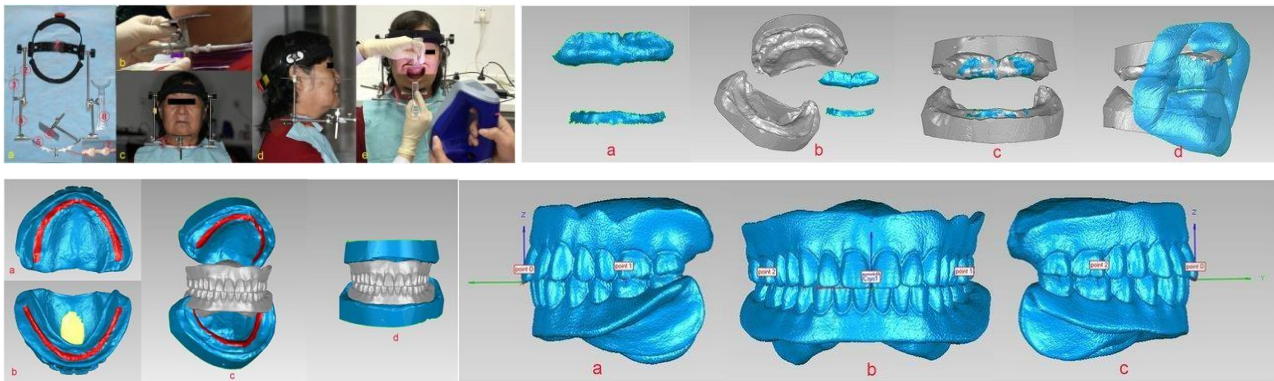
Reference   **Presented by Pf. YoungBum Park**

Papaspyridakos P, Chochlidakis K, Kang K, Chen YW, Alghfeli A, Kudara Y, Weber HP. Digital Workflow for Implant Rehabilitation with Double Full-Arch Monolithic Zirconia Prostheses. J Prosthodont. 2020 Jul;29(6):460-465. doi: 10.1111/jopr.13166. Epub 2020 Apr 9. PMID: 32185825.

Li W, Xie Q, Wang Y, Sun Y. A pilot study of digital recording of edentulous jaw relations using a handheld scanner and specially designed headgear. Sci Rep. 2018 Jun 12;8(1):8975. doi: 10.1038/s41598-018-27277-5. PMID: 29895978; PMCID: PMC5997633.

Kanazawa M, Iwaki M, Arakida T, Minakuchi S. Digital impression and jaw relation record for the fabrication of CAD/CAM custom tray. J Prosthodont Res. 2018 Oct;62(4):509-513. doi: 10.1016/j.jpor.2018.02.001. Epub 2018 Mar 17. PMID: 29555174.

Lepidi L, Galli M, Mastrangelo F, Venezia P, Joda T, Wang HL, Li J. Virtual Articulators and Virtual Mounting Procedures: Where Do We Stand? J Prosthodont. 2021 Jan;30(1):24-35.

Issue

Does the orientation of the bevel on scan bodies affect the accuracy of digital implant scans?

Consensus

- The orientation of the bevel on scan bodies can influence the accuracy of digital implant scans. Specifically, when the bevel is oriented towards the proximal sides, such as the mesial or distal, it may result in less accurate scan results.

- It is recommended that the bevel should not be positioned proximally when attaching scan bodies to implants in order to optimize the accuracy of the scans.

Reference   Presented by **Prof Dr Jae-Hyun Lee**

1. Wan Q, Limpuangthip N, Hlaing NHMM, Hahn S, Lee JH, Lee SJ. Enhancing scanning accuracy of digital implant scans: A systematic review on application methods of scan bodies. *J Prosthet Dent.* 2024:S0022-3913(24)00426-8. doi: 10.1016/j.prosdent.2024.06.010.

2. Gómez-Polo M, Álvarez F, Ortega R, Gómez-Polo C, Barmak AB, Kois JC, Revilla-León M. Influence of the implant scan body bevel location, implant angulation and position on intraoral scanning accuracy: An in vitro study. *J Dent.* 2022;121:104122.

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Issue 1

How should a customized abutment designed for a functional, esthetic, and biologically acceptable prosthesis ?

Consensus

There are so many types of design for dental implant abutment. Among these, the customized abutment reflect best the patient's hard and soft tissue conditions.

The subgingival configuration of customized abutment is related to the marginal bone loss and biologic compliactions of peri-implant mucosa.

There are no consensus about a supragingival design of customized abutment.
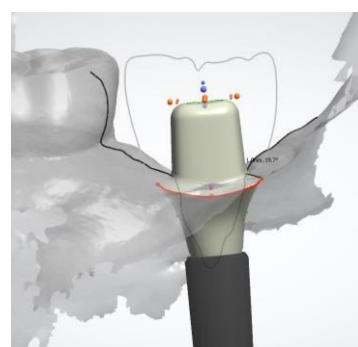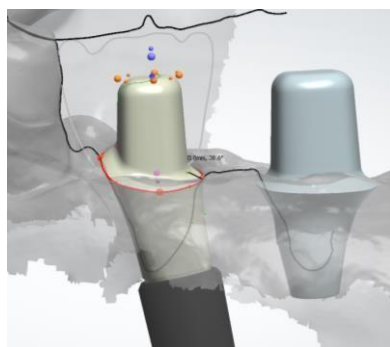
 The customed abutment design is divided into a subgingival and supragingival part. The supra gingival part contains the width of the margin, the degree of curvature of the incisal portion and the angle and axis of the abutment and these values are determined by clinical judgment. The emergence profile and appearance (convex, straight, concave profile) is very important for the subgingival part.

Dr. Hur Yin Shik

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4. Yi Y, KooKT, Schwarz F, Ben Amara H, HeoSJ. Association of prosthetic features and peri-implantitis: A cross-sectional study. J. Clin. Periodontol. 2020; 47:392-403