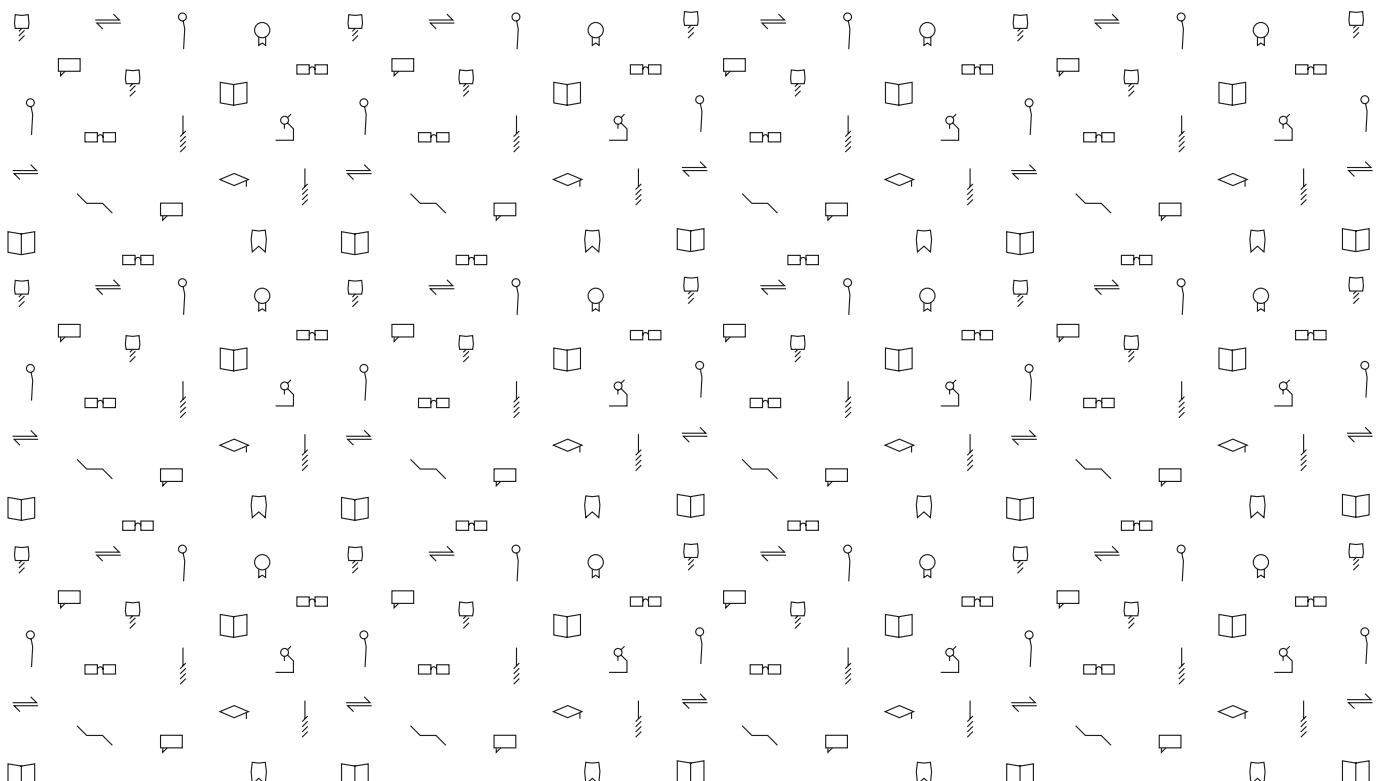


# Key points for clinical practice from the EAO Consensus Conference





Group 1: Drugs and diseases



Group 2: Biological parameters



Group 3: Reconstructions



Group 4: Biomechanical aspects



Group 5: Consensus Conference reporters

# Introduction

The European Association for Osseointegration (EAO), **Europe's leading association for implant dentistry**, holds a Consensus Conference every three years, during which experts debate key areas of dental practice and reach a consensus. These conferences are fully funded by the Association to ensure that the findings are free from any commercial influence.

**60 top scientists from around the world** participated in the 2018 conference, held in Switzerland in February 2018 and discussed the following themes, which were broken down into several sub-topics:

- > **Drugs and diseases**
- > **Biological parameters**
- > **Reconstructions**
- > **Biomechanical aspects**

A group of scientists already involved with preparing reports on the EAO annual congresses were asked to participate as observers in the work sessions and summarise the discussions. This summary has become the **“Key points for clinical practice”**, and it was prepared by Lino Esteve, Alberto Salgado, Guillem Esteve, Luis Miguel Sánchez and Javier Amigó on behalf of the EAO. It was created to share information in an easily and accessible way for all clinicians in the field of dentistry and to complement the official **Proceedings of the 5th Consensus Conference published in COIR.**

For more information on the EAO and its projects, visit [www.eao.org](http://www.eao.org)

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Part 1

# Drugs and diseases





# Platelet concentrates



## Clinicians' questions

### **What is the current evidence to support the use of platelet concentrates (PC) in implant therapy? Is the use of PCs worthwhile?**

There is currently limited evidence to support possible recommendations. However, no negative side effects associated with the use of PC have been reported.

### **Do all PCs have similar effects or should they be recommended differently?**

There are several different classifications for PCs. A distinction must be made between platelet-rich plasma (PRP), preparation rich in growth factors (PRGF) and platelet-rich fibrin (PRF), as these have been tested and found to have different results. Additionally, the possible recommendations for each depend on the specific clinical indications.

### **Do PCs improve implant success rates?**

Neither PRP nor PRGF have been shown to improve implant stability or reduce marginal bone loss (MBL) following implant placement. A randomised clinical trial (RCT) was carried out to determine whether the use of PRF can lead to better ISQ values and lower levels of MBL, but there is currently insufficient evidence to support a clinical recommendation on this basis.

### **Do PCs improve the results of alveolar ridge preservation (ARP)?**

PRP and PRGF have not been shown to improve the outcome of ARP procedures, whether used alone or in conjunction with graft materials. PRF, however, has been found to limit post-extraction bone resorption and therefore can be recommended.

### **Can PCs improve the outcome of ridge augmentation procedures?**

PRP has been shown to improve the clinical results of augmentation procedures and may be recommended. However, PRGF and PRF have not been evaluated for this indication.

### **Are PCs beneficial in sinus-lift procedures when used in combination with autogenous bone and/or bone substitutes?**

None of the PC variants have been found to be superior to conventional sinus-lift techniques; they are therefore not recommended.

### **Are there any other possible recommendations for PCs?**

It has been shown that the use of PRF in open-flap debridement of peri-implantitis can lead to improved results, but the data supporting this is limited and cannot support a clinical recommendation.



## Key points

- 1. Generally speaking, there is insufficient evidence supporting the use of PCs**
- 2. PRP, PRGF and PRF have been proven to have different effects depending on the clinical indication**
- 3. PRF can be used in alveolar ridge preservation, but PRP and PRGF have shown no additional benefits for this indication**
- 4. The use of PRP may be recommended in augmentation procedures, but limited evidence is available on this matter**
- 5. None of the PCs are recommended for sinus-lift procedures as they have not been proven to have any additional benefits to the conventional procedure**

# Titanium particles: bio-corrosion and allergy



## Clinicians' questions

**There seems to be a growing tendency for attributing harmful tissue reactions to titanium, and some patients' bodies reject metals. Do titanium allergies exist? Should clinicians prescribe an allergy test before starting implant treatment?**

The evidence is weak, but patient hypersensitivity to titanium cannot be definitively ruled out. Given the limited number of cases reported and the poor specificity of symptoms, a precautionary allergy screening cannot currently be recommended as routine practice. Moreover, patch tests and lymphocyte immunostimulation assays seem to give inconclusive results and are often found to give false positives.

**OK. Titanium allergies can be considered a minor problem, but particles of titanium have been detected in peri-implant tissues. Where do they come from?**

Although titanium is less susceptible to corrosion than other metals, it is still possible due to mechanical wear and environmental chemical agents. Mechanical wear can occur during implant placement and can be caused by micro-motion between implant and prosthetic components, or by external factors such as cleaning or chewing. Chemical corrosion can be exacerbated by the acidic environment caused by biofilms and tissue inflammation. The combination of these factors can lead to the release of particles from the implant surface in a process called 'tribocorrosion'.

However, it should be noted that because titanium is so ubiquitous in daily life and used in so many consumer goods that Ti particles can be found in human tissues whether they have dental implants or not.

**In that case, is the presence of titanium particles clinically irrelevant?**

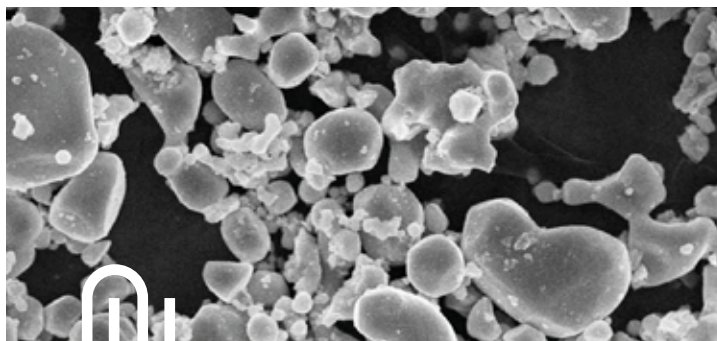
Before answering this question, it should be noted that titanium debris has been shown to have cytotoxic and pro-inflammatory effects in vitro. Thus, Ti particles may increase the production of cytokines and therefore be involved in bone resorption.

**Is it likely that this contributes to biological complications in implants?**

In 15 studies examining the data on titanium particles in peri-implant tissues, no direct correlation could be found. The true clinical impact of the presence of titanium particles remains unclear.

**If titanium particles are cytotoxic, could they influence implant survival/success and cause biological complications?**

It can be stated that Ti particles do not play a role in early implant failures. Their role in causing or exacerbating peri-implantitis is also unclear, particularly because abrasive treatment approaches may in fact cause further contamination of the peri-implant tissues with titanium particles from the implant surface. In spite of this, however, these treatments do have a certain degree of success. It can be stated that there is no evidence that Ti particles should lead clinicians to select implant materials other than titanium.



## Key points

- 1. Although the evidence is weak, hypersensitivity to titanium cannot be definitively excluded**
- 2. Allergy tests are not recommended on a routine basis because they are prone to giving false-positive results**
- 3. Titanium particles can be present in peri-implant tissues as a result of 'tribocorrosion', but their clinical impact (if any) is unclear**
- 4. There is no evidence to prove that titanium particles play a causative role in peri-implantitis**

# Anti-resorptive drugs and implant therapy



## Clinicians' questions

**More and more low-dose anti-resorptive drugs (ARDs) like bisphosphonate and denosumab are prescribed around the world to treat the effects of osteoporosis. Patients being treated with ARDs often come to practices looking for implants. What are the risks?**

Implant patients receiving low-dose oral bisphosphonates are at risk of MRONJ, although the risk factor appears to be low.

**Does the duration of the ARD intake have an impact on the occurrence of MRONJ?**

Yes. In all patients taking low-dose ARDs (bisphosphonates and denosumab), the risk of MRONJ increases with intake duration. In 71% of patients with MRONJ, the reaction occurred more than 36 months after they commenced drug intake.

**A 'drug holiday' has been recommended in some published clinical guidelines. Does the interruption of ARD intake have an effect on the incidence or risk of MRONJ?**

The evidence supporting this is lacking, so the recommendation remains unclear.

**Is there an increased risk for early or late implant failures in these patients?**

Higher rates of implant loss have not been reported in patients taking low-dose ARDs than in the control groups. The longevity of implants was also not found to be compromised in those who were receiving low-dose ARDs. The possible effect of low-dose subcutaneous and intravenous ARD administration is unclear but appears to be comparable. Little data is available on the safety of bone grafting procedures performed at the time of implant placement, so conclusions cannot be drawn on this matter.

**After reviewing the existing documentation, what should I do?**

Low-dose ARDs cannot be considered a contraindication for implant placement, but there is insufficient data available supporting its use in bone grafting procedures.

In these patients, an individual assessment of risk factors (e.g. local factors, smoking, systemic diseases, co-medications, and duration of ARD intake) and prophylactic use of antibiotics and postoperative antiseptics (e.g. chlorhexidine) are recommended. A drug holiday should only be suggested following a consultation with the treating physician.

Implant therapy and/or bone grafting procedures are currently not recommended in patients on high-dose ARD intake.



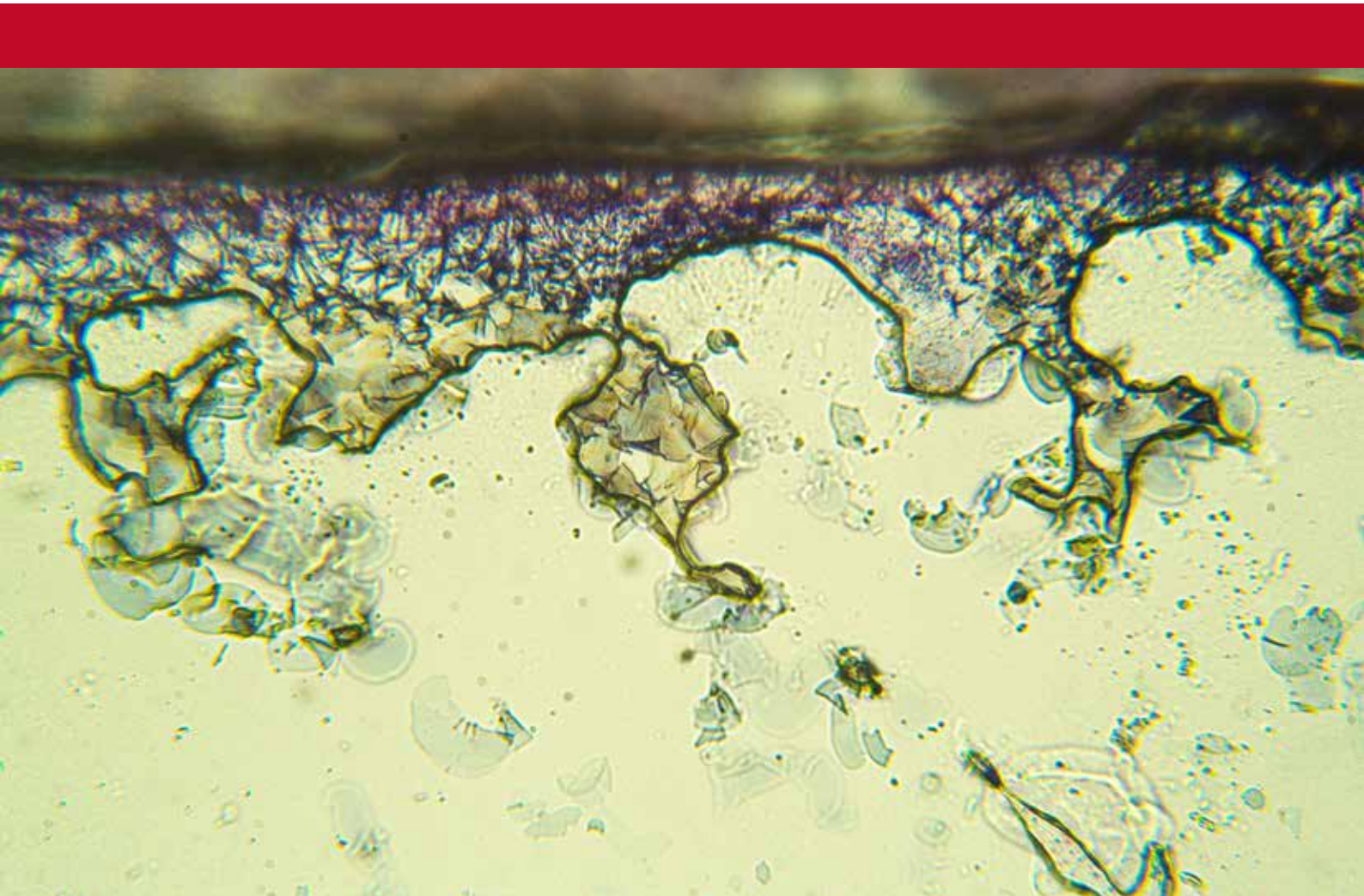
## Key points

- 1. Patients receiving low-dose ARDs (bisphosphonates and denosumab) are at risk of MRONJ, although the risk factor is considered low**
- 2. The risk for MRONJ increases with the duration of drug intake. The effectiveness of drug holidays to mitigate this risk is unclear**
- 3. ARDs are not associated with higher instances of early or late implant failure**
- 4. Low-dose ARDs are not considered a contraindication for implant placement. There is no data available on bone grafting**
- 5. Implant therapy and/or bone grafting procedures are currently not recommended in patients on high-dose ARD intake**



Part 2

# Biological parameters



# Abutment material and peri-implant tissues



## Clinicians' questions

**In addition to titanium, zirconia, alumina, gold, lithium disilicate and titanium nitride are also used as implant abutments. Do these materials perform similarly in clinical practice?**

A meta-analysis including 29 studies on 954 patients (1,266 implants) showed no statistical differences between these abutment materials either in terms of marginal bone loss (MBL), implant survival or incidence of complications over a mean follow-up of 30 months (range: 6 to 86.4).

**Although the documented clinical performance seems to be similar, can any differences in peri-implant tissue reactions be measured between the abutment materials?**

No statistically significant differences in mean probing depth (PD), bleeding on probing (BoP) or plaque accumulation (PA) could be identified in the RCTs. However, a separate comparison of zirconia and titanium abutments reported significantly higher levels of BoP with titanium. Similarly, there was a trend for more PA around titanium abutments than with zirconia ( $p=0.068$ ).

**All the tested materials seem to have comparable clinical and biological responses. But what is its effect on patient satisfaction and aesthetics?**

Patient satisfaction with the implant-supported prostheses was generally high, and no differences could be attributed to abutment materials. Moreover, the meta-analysis did not detect a difference between the abutment materials in aesthetic index scores. Other studies not included in the present systematic review, however, reported significantly better results for ceramic abutments than titanium in terms of mimicking natural soft tissue colour.

**In conclusion, what is the most suitable abutment material to use?**

Titanium should continue to be considered the abutment material of choice in general clinical practice. However, other materials – zirconia and alumina above all – have been shown to work equally well and should be considered appropriate for clinical use. In particular, zirconia has been found to achieve better results than titanium in regard to PA and BoP.

Future research should focus on soft tissue integration and the anti-biofilm properties of abutment materials. No new abutment materials should be introduced to the market without having been thoroughly tested and without the appropriate corresponding documentation.



## Key points

- 1. Titanium is the abutment material of choice for most clinical indications**
- 2. There is no apparent difference between titanium and other abutment materials in terms of implant survival, marginal bone loss or incidence of complications**
- 3. Zirconia abutments tend to be associated with less plaque accumulation and bleeding on probing**
- 4. Some studies found that ceramic abutments were superior to titanium abutments in terms of aesthetic appearance of tissues**

# Diagnostic parameters and peri-implantitis



## Clinicians' questions

**Peri-implantitis affects the predictability of long-term implant survival and success rates. Appropriate treatment guidelines are lacking and the precise prevalence of the disease is unknown. How are peri-implantitis cases currently defined in prevalence studies?**

Case definitions of peri-implantitis usually consist of composite evaluations of peri-implant tissue inflammation, such as bleeding on probing, bleeding scores, or assessments of marginal bone loss with different thresholds (ranging from  $<1$  to  $>3$  mm). However, among the 41 studies evaluating peri-implant tissue inflammation which were included in the present review, there were many discrepancies between the case definitions reported. 15 lacked a case definition and the remaining 26 studies applied 15 different criteria.

**Are diagnostic parameters still valid for gauging the real prevalence of peri-implantitis?**

When assessing the mean values of the three diagnostic parameters (MBL, BoP and PD), the values did not correlate with the reported prevalence of peri-implantitis. The mean values are therefore not adequate parameters for assessing the prevalence of the disease. Rather than mean values, frequency distribution of diseased sites should be considered the most appropriate outcome measure.

**How should peri-implantitis be diagnosed in clinical practice?**

The diagnosis should not be based on a single parameter, but on multiple clinical and radiographic parameters. It should be necessary for these parameters to be obtained at baseline for reference, preferably after the bone adaptation stage and once the peri-implant tissues have fully healed. The baseline parameters should be used to detect significant changes in peri-implant tissues, and should be used as a basis for diagnosis of peri-implantitis. In the absence of baseline values, certain thresholds which are generally accepted may be used (for example, if the radiographic bone level is 3mm from the coronal portion of the intraosseous component of the implant).

New diagnostic tools are needed with improved sensitivity and specificity which would allow clinicians to assess changes in marginal bone levels and distinguish between healthy and diseased peri-implant soft tissues.



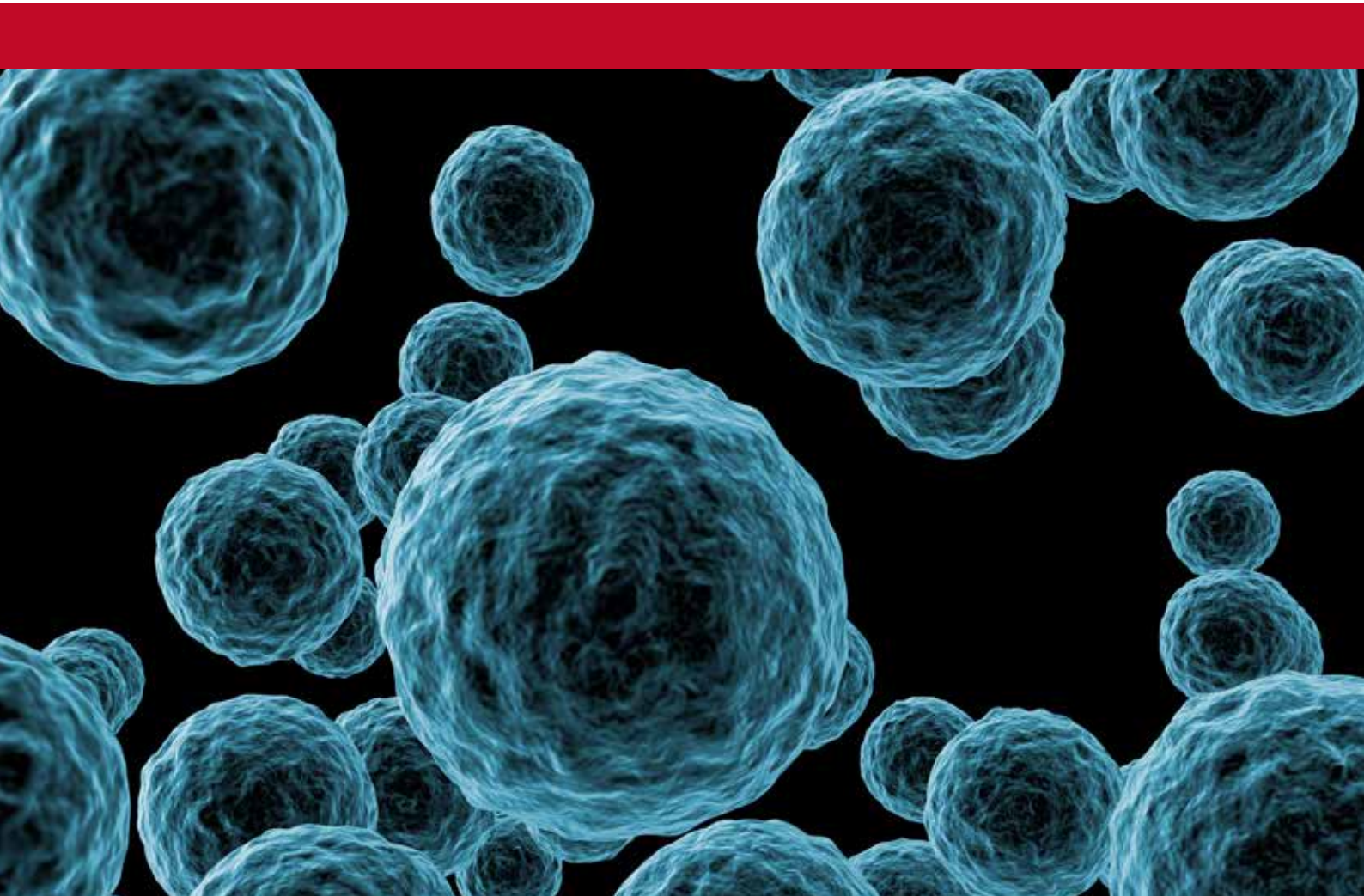
## Key points

- 1. A homogeneous and internationally accepted case definition for peri-implantitis is needed**
- 2. Baseline parameters should be recorded a few months after the placement of the final prosthesis to be used as reference values**
- 3. Peri-implantitis should not be diagnosed based on a single measure, but on a combination of clinical and radiographic parameters, such as PD, BoP and MBL**



Part 3

# Reconstructions



# Conventional vs digital workflows



## Clinicians' questions

### How would the switch to a digital workflow benefit me in my office?

Further studies are needed to explore this, but the evidence currently available seems to suggest that the process for creating impressions is quicker using a digital workflow.


### And could the laboratory deliver prostheses more quickly and more cheaply using a digital workflow?

In cases involving posterior single-implant crowns, yes. In terms of time: lab procedures are fastest when a model-free fabrication is used, as well as a pre-fabricated abutment and a monolithic design. In terms of cost: it depends on the country (labour costs, centralisation, and amortisation of equipment).



## Consensus viewpoint

There is currently insufficient data available to evaluate all factors involved in a digital workflow. We are in the midst of a 'hybrid phase', where digital and conventional procedures are often combined. The exact division of when to use one or the other is highly dependent on individual clinicians' preferences, and no recommendations can be made based on the present consensus. Further crossover studies are needed to evaluate digital workflows utilising different systems, under various operators' circumstances and appropriately recording patient-related outcome measures, time-efficiency, cost-effectiveness and clinical results.



## Key points

- 1. The use of either digital or conventional procedures at any stage of the treatment process depends on the preferences of the clinician**
- 2. Digital procedures in both a clinical and lab setting may be faster and cheaper than conventional ones in some cases, but there is not enough data yet to give practical recommendations**



# All-ceramic single-implant crowns



## Clinicians' questions

### Can I avoid metals in single-implant crowns? Are all-ceramic crowns reliable on single implants?

Yes. All-ceramic crowns (veneered on alumina, zirconia, lithium-disilicate, or leucite-reinforced and monolithic crowns on lithium-disilicate) can be considered a valid option for restoring single implants (either cemented or screw-retained) both in anterior and posterior locations.




## Consensus viewpoint

Data from 2,200 crowns with various framework and ceramic veneering configurations was gathered for statistical analysis. Crowns showed a high 5-year survival rate – above 95% – in line with those generally reported for single-implant restorations. After 5 years, chipping occasionally occurred: in veneered alumina 1.8%; veneered glass-ceramics 2.8%; monolithic lithium disilicate 6%; and veneered zirconia 11.3%.

The long-term outcome of all-ceramic crowns is highly dependent on the manufacturing process and clinical handling. It is also recommended that patients be informed of potential technical complications from the outset.

However, the review found that resin-based hybrid ceramic crowns were associated with significantly more core fractures than veneered alumina and zirconia crowns, and the mean 5-year survival rate dropped to 67% with hybrid ceramic crowns. This kind of crown can therefore not be recommended for clinical use. At present, no consensus statement can be made regarding zirconia crowns due to the lack of longitudinal data.



## Key points

- 1. All-ceramic crowns on single implants can be expected to perform reliably in all indications**
- 2. Resin-based hybrid ceramic crowns are not recommended because of high fracture rates at 5-year follow-ups**
- 3. Due to lack of longitudinal data, no statement can currently be made concerning monolithic zirconia crowns**

# All-ceramic partial and full-arch prostheses



## Clinicians' questions

**Partial and full-arch zirconia frameworks are being used more often in implant prostheses. To what extent does the current evidence support these types of reconstructions?**

Implant-supported prostheses on veneered zirconia have shown short-term survival rates as high as 98%. Unfortunately, however, a high incidence of chipping has also been reported: 22.8% for partial-arch reconstructions and 34.8% for full-arch.



## Consensus viewpoint

Due to the high incidence of chipping reported, the prognosis of these reconstructions should be considered questionable. Patients should be informed of the potential technical complications in advance. Partial monolithic zirconia reconstructions seem to be viable alternatives to prevent chipping, but for the moment there is insufficient data to support this.



## Key points

**1. Veneered zirconia in partial and full-arch fixed prostheses is associated with such high chipping rates that it cannot be recommended**

**2. There is limited data available on monolithic zirconia reconstructions**

# Abutments and connections



## Clinicians' questions

### What is the best abutment material for single-implant crowns?

All abutments – either metallic or ceramic, with internal or external connections, in anterior or posterior cases, cemented or screwed – have similar clinical results.

### And for a fixed partial denture, which abutment material should I use?

Zirconia abutments are still lacking sufficient longitudinal data for partial fixed dentures. Therefore, only metallic abutments can be recommended. Metallic abutments are suitable for either internal or external connections and for cemented or screw-retained restorations.




## Consensus viewpoint

Despite various limitations of the review, a meta-analysis of about 6,000 abutments from 60 studies with an estimated medium 5-year survival rate of 96.5% was performed. Regarding failures and complications, no statistical significance was noted either for single or partial restorations, or for cemented/screwed or external/internal connections. There is still limited evidence available regarding ceramic abutments in posterior areas, especially for partial fixed dentures.

Although the results were not statistically significant, external connections were more frequently associated with screw loosening and ceramic abutments fractured more often.

More studies are required on ceramic and monolithic reconstructions. The studies should use more reliable research parameters and have enough statistical significance to shed light on materials used, connections, and type of retention of the restorations. Proper documentation is highly recommended to obtain valid conclusions for clinical practice.

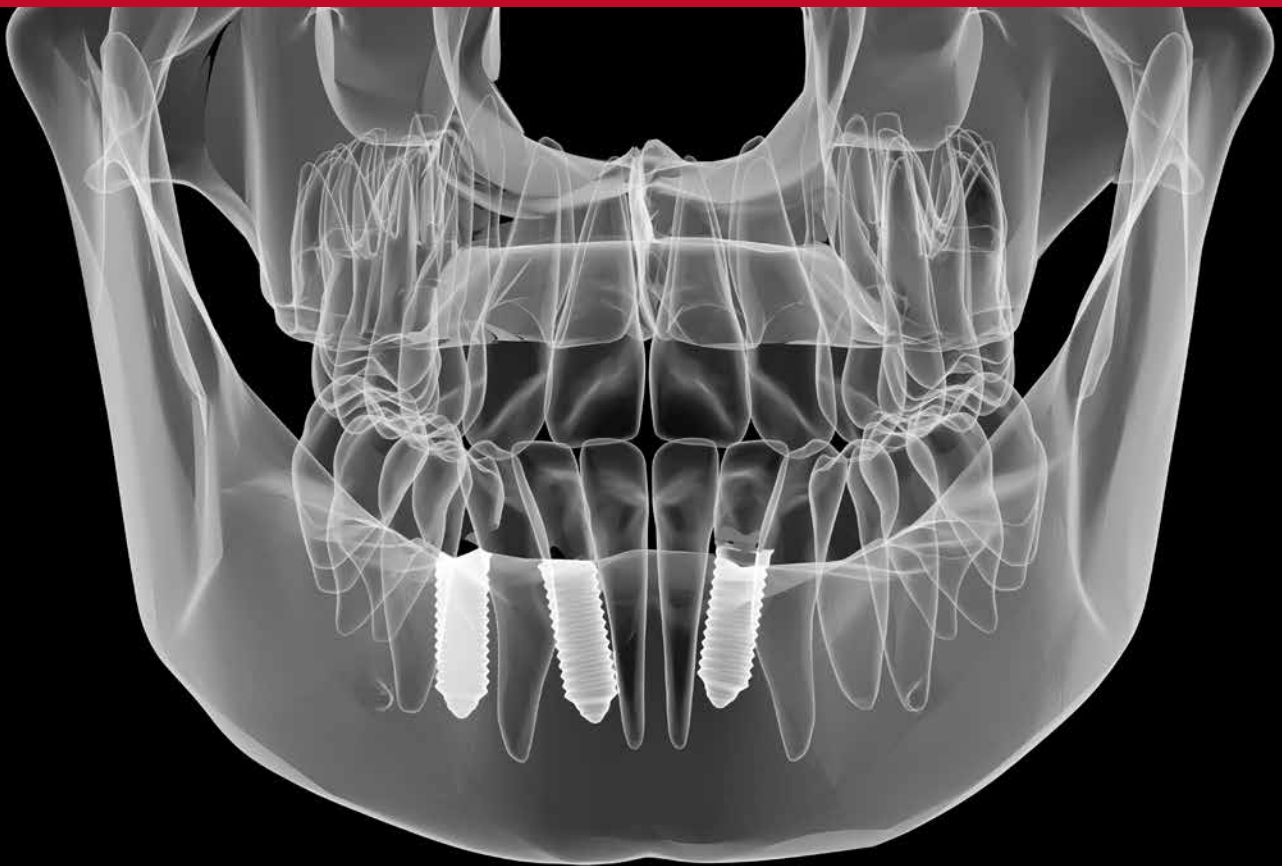


## Key points

1. For a single-implant crown, all abutment materials, connections and types of retention have similar clinical results
2. For fixed partial prostheses, zirconia abutments are still not recommended because of lack of evidence

Part 4

# Biomechanical aspects



# Crown-to-implant ratios and implant treatment outcomes



## Clinicians' questions

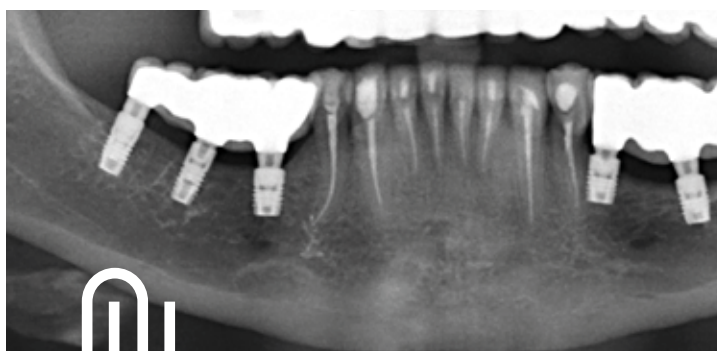
### Should I worry when an implant is short and the inter-occlusal space is long? Does splinting make a difference in cases involving short implants?

In splinted implants, supposedly unfavourable crown-to-implant ratios did not show more failure or complication rates. In single-implant restorations crown-to-implant ratios from 0.9 to 2.2 have not been associated with the occurrence of biological or technical complications. Hence short implants with long crowns can be considered a valid treatment option to simplify or avoid more complex augmentation procedures.



## Consensus viewpoint

It is not known whether crown-to-implant ratios of various sizes could influence survival or complication rates. Nor is there any data available on the performance of these types of prostheses between two dental units compared with distal end prostheses. Although clear evidence exists on the viability of crown lengths (up to double the implant length), randomised long-term studies are needed to compare these crown-to-implant ratios with longer implants in augmented bone and prostheses with normal dimensions.



## Key points

- 1. Crown lengths up to double the implant size have not been associated with biological or technical complications in single or splinted reconstructions**
- 2. Short implants with long crowns could be a simpler alternative for complex augmentation procedures**



# Tilted implants and treatment outcomes



## Clinicians' questions

### Can I tilt implants to compensate for anatomical limitations? How does tilting implants influence results?

Data gathered from 17 studies on 1,584 patients did not reveal significant differences between tilted and straight implants in terms of in medium-term survival rates or marginal bone loss.

### Does that mean that straight and tilted implants perform equally?

Unfortunately, restorations with similar characteristics which are supported by tilted or straight implants have never been compared in a prospective study. Nor has the angulation of an implant been evaluated as a separate risk factor. Hence it is still not known whether tilting implants has an influence on peri-implant soft tissues or on prosthetic complications.

### But are tilted implants still a valid treatment option?

Yes, but they are not the only option. The current recommendation is to carefully evaluate possible treatment alternatives on an individual basis.



## Key points

- 1. The outcomes reported with tilted and straight implants are comparable in terms of medium-term survival rates and marginal bone loss**
- 2. Prospective studies comparing tilted and straight implants are needed**

# Cantilevers in full-arch prostheses



## Clinicians' questions

### When treating edentulous patients, can I avoid placing posterior implants? Are cantilevers a reliable treatment option?

Full-arch prostheses on intermental or intersinus implants with cantilevers have been shown to be a good solution for reducing treatment complexity. This concept works in both jaws, either with traditional parallel implants or with two tilted distal implants (provided that cantilevers do not exceed 20mm and do not replace more than two occlusal units).



## Consensus viewpoint

Full-arch cantilevered reconstructions were found to have high implant and prosthesis survival rates at 5–10 years of follow-up (97% and 99% respectively). However, the rate of complications was as high as 39% with prostheses and mostly consisted of fractures of the veneering material, especially when resin was used.

This is clinically significant as it may have an impact on patient satisfaction. Clinicians should be aware of the potential problems and discuss them with patients from the very beginning of the treatment.

However, there have been no studies comparing full-arch reconstructions with or without cantilevers. We therefore do not know if cantilevers can or cannot be considered a specific risk factor for technical complications. There is still a lack of evidence on this matter.



## Key points

**1. Full-arch reconstructions with cantilevers up to 20mm (two units) long perform well in the long term on both edentulous jaws**

**2. Full-arch implant-supported reconstructions have a very high rate of chipping, but it is still unknown whether cantilevers present an additional level of risk for technical complications**

# Cantilevers in partial fixed prostheses



## Clinicians' questions

**Cantilevers appear to work reliably in edentulous patients, but can I use cantilevers in partially edentulous patients? Will I encounter more complications using cantilevers in implant-supported partial reconstructions?**

Cantilevers in partial fixed prostheses have been proven to be a viable option. They can be used predictably when treatment needs to be simplified or in cases involving anatomical limitations.

**OK. Cantilevers in partially edentulous patients can be considered a valid option for complex cases to avoid more advanced surgery or for aesthetic reasons. But in view of so many biomechanical complications what would be the safe optimal length of the cantilever?**

The evidence currently available covers cantilevers as small/short as 6mm and up to two occlusal units long. The mean length of the cantilevers is 10mm.

**Once we have checked that cantilevers work, can I also safely place prostheses on a single implant supporting one crown and one cantilevered pontic?**

Only two retrospective studies on 44 prostheses were included, and showed a 97% survival rate in 6–18 years of follow-up. But the data is so scarce that this design still cannot be recommended for routine clinical use.



## Consensus viewpoint

In partially edentulous patients with mesial or distal cantilevered fixed prostheses, both implant and prosthesis survival rates reached 98% for multi-unit bridges. But only 73% of the restorations remained free of complications in the medium term. The majority of complications were technical, such as chipping or fractures of the porcelain. No framework fractures were reported, and implant fractures occurred in only 0.3% of implants. Cantilevers in partial prostheses can be recommended, provided that the potential complications are taken into account and provided that clinicians know that this recommendation is based on a few studies with a high risk of bias.



**Key points**

- 1. In partial reconstructions, cantilevers (either mesial or distal, and up to two units or 10mm) can be considered a valid option to simplify treatment, but they seem to present more technical complications**
- 2. We have very little data on cantilevers on single implants, so they cannot be recommended for routine use**

# Positional changes between the natural teeth and implant-supported restorations over time



## Clinicians' questions

### What happens with implant-supported restorations in the long term? How do they evolve in relation to natural dentition?

In half of implant-supported restorations, infra-position or missing proximal contact points were detected after a mean follow-up of 5.7 years (range: 1 to 18). Both of these were found to increase over time. Missing contact points were encountered more often in mesial regions/areas, and infra-position was more frequent in females. The older the patient at the time of the implant placement, the less infra-position was observed.



## Consensus viewpoint

Positional changes were shown to occur when placing implants in young patients. But it should be noted that this potential complication can also affect adult patients. Although the clinical consequences of these changes have rarely been reported, it is likely that implant restorations in the long term may require some kind of re-intervention.



## Key points

1. In the long term, implant restorations are susceptible to positional changes in relation to natural teeth (infra-position and missing contact points), even in adult patients





