## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledgements</td>
<td>4</td>
</tr>
<tr>
<td>Methodology</td>
<td>4</td>
</tr>
<tr>
<td>Copyright</td>
<td>4</td>
</tr>
<tr>
<td><strong>Decision-making on the basis of the level of disease:</strong></td>
<td></td>
</tr>
<tr>
<td>conservation versus extraction</td>
<td>5</td>
</tr>
<tr>
<td>Periodontal therapy or implant therapy? How do we judge when to select one or the other?</td>
<td>5</td>
</tr>
<tr>
<td>Deciding between conservation or extraction of periodontally compromised teeth with a questionable prognosis</td>
<td>6</td>
</tr>
<tr>
<td><strong>Soft and hard tissue grafting: prevention and management of complications</strong></td>
<td>7</td>
</tr>
<tr>
<td>Prevention and management of soft tissue defects around implants</td>
<td>7</td>
</tr>
<tr>
<td>GBR in vertical and horizontal defects: how to reduce complications</td>
<td>9</td>
</tr>
<tr>
<td>How to reduce complications using autogenous bone blocks</td>
<td>10</td>
</tr>
<tr>
<td><strong>A digital revolution</strong></td>
<td>12</td>
</tr>
<tr>
<td>Virtual smile design to drive the restorative plan</td>
<td>12</td>
</tr>
<tr>
<td>3D engineering in contemporary implant dentistry</td>
<td>13</td>
</tr>
<tr>
<td>Optical impression and implant reconstruction: where are we?</td>
<td>15</td>
</tr>
<tr>
<td><strong>40,000 implants down the road: What did we learn?</strong></td>
<td>16</td>
</tr>
<tr>
<td>Some thoughts on ailing and failing implants</td>
<td>16</td>
</tr>
<tr>
<td>40,000 implants down the road: what did we learn?</td>
<td>18</td>
</tr>
<tr>
<td><strong>Contest by the Junior Committee: ‘7 minutes to convince’</strong></td>
<td>21</td>
</tr>
<tr>
<td>An original concept to present new research in implant dentistry</td>
<td>21</td>
</tr>
<tr>
<td>Digital working in implantology (parts 1 and 2)</td>
<td>21</td>
</tr>
<tr>
<td>The conometric concept to make fixed implant-supported restorations</td>
<td>22</td>
</tr>
<tr>
<td>A customised solution for 3D defects</td>
<td>23</td>
</tr>
<tr>
<td>Effective implant surface decontamination during peri-implantitis treatment: what is the secret?</td>
<td>24</td>
</tr>
<tr>
<td>Point of view perspective of a dental implant patient</td>
<td>24</td>
</tr>
<tr>
<td>Voids and areas of reduced mineralisation in healed sinus grafts: a prospective study using immediate and 6 months’ cone beam computerised tomography</td>
<td>25</td>
</tr>
<tr>
<td>Results</td>
<td>25</td>
</tr>
<tr>
<td><strong>Treatment planning session: a clinical case with a ‘complex’ problem or involving extensive rehabilitation</strong></td>
<td>26</td>
</tr>
<tr>
<td>Case presentation</td>
<td>26</td>
</tr>
<tr>
<td>The clinical decision-making process for extraction and implant placement</td>
<td>27</td>
</tr>
<tr>
<td>Clinical decision-making process</td>
<td>29</td>
</tr>
<tr>
<td>Case completion</td>
<td>30</td>
</tr>
<tr>
<td><strong>Festival of complications</strong></td>
<td>31</td>
</tr>
<tr>
<td>Treatment planning away from biological and technical complications</td>
<td>31</td>
</tr>
<tr>
<td>Removable implant reconstructions: factors influencing incidence and type of complications</td>
<td>32</td>
</tr>
<tr>
<td>How to solve – or better how to avoid – technical complications</td>
<td>34</td>
</tr>
<tr>
<td><strong>Bone biology: where do we stand?</strong></td>
<td>35</td>
</tr>
<tr>
<td>Cell biology and immune response related to implant dentistry</td>
<td>35</td>
</tr>
<tr>
<td>Bone to implant interface: where do we stand and where do we go?</td>
<td>37</td>
</tr>
<tr>
<td>What is osseointegration in 2016 and why are we losing bone around dental implants?</td>
<td>38</td>
</tr>
<tr>
<td><strong>Tips and tricks for a successful implant practice</strong></td>
<td>40</td>
</tr>
<tr>
<td>Introduction to the EAO Education Programme</td>
<td>40</td>
</tr>
<tr>
<td>How photography can improve your private practice</td>
<td>42</td>
</tr>
<tr>
<td>Private practice management and development</td>
<td>43</td>
</tr>
<tr>
<td><strong>How to avoid the carpenter’s approach to implants</strong></td>
<td>44</td>
</tr>
<tr>
<td>The influence of insertion torque on primary stability, implant survival and marginal bone loss</td>
<td>44</td>
</tr>
<tr>
<td>Evidence-based implant carpentry. What are you using, what are we doing?</td>
<td>46</td>
</tr>
<tr>
<td>Bone versus implants! Do we need to grant the biomechanical to the biological? The orthopaedist’s perspective</td>
<td>47</td>
</tr>
<tr>
<td><strong>Emerging technologies: head-to-head</strong></td>
<td>48</td>
</tr>
<tr>
<td>Hand guided surgery versus guided surgery</td>
<td>48</td>
</tr>
<tr>
<td>Autogenous bone blocks versus allogeneic bone blocks</td>
<td>50</td>
</tr>
<tr>
<td>Connective tissue graft versus soft tissue substitute around implants</td>
<td>52</td>
</tr>
<tr>
<td><strong>Optimal long-term results for osseointegrated implants</strong></td>
<td>53</td>
</tr>
<tr>
<td>A new strategy for bone augmentation</td>
<td>53</td>
</tr>
<tr>
<td>An analysis of dental implant treatment based on biomechanics and mechanobiology</td>
<td>54</td>
</tr>
<tr>
<td><strong>Implantology needs periodontology</strong></td>
<td>56</td>
</tr>
<tr>
<td>Periodontal plastic surgery to prevent biological complications in the aesthetic zone</td>
<td>56</td>
</tr>
<tr>
<td>Bone management for optimal aesthetic outcomes</td>
<td>58</td>
</tr>
<tr>
<td><strong>Things we stopped in our practice due to failures</strong></td>
<td>60</td>
</tr>
<tr>
<td>Immediate implant placement</td>
<td>60</td>
</tr>
<tr>
<td>Prosthodontic rehabilitation of edentulous jaws</td>
<td>62</td>
</tr>
<tr>
<td>Immediate CAD/CAM restoration</td>
<td>63</td>
</tr>
<tr>
<td>Cement-retained restorations</td>
<td>64</td>
</tr>
<tr>
<td><strong>Debate: ‘machined or rough implants’?</strong></td>
<td>66</td>
</tr>
<tr>
<td>Machined vs. rough implants: 30 years of experience</td>
<td>66</td>
</tr>
<tr>
<td>Clinical advantages of modern micro-rough implant surfaces</td>
<td>67</td>
</tr>
<tr>
<td><strong>Please give me back my smile! Decision-making in the aesthetic zone: challenge your speakers</strong></td>
<td>68</td>
</tr>
<tr>
<td>How to manage complex cases in the anterior maxilla using a multidisciplinary approach</td>
<td>68</td>
</tr>
<tr>
<td>Contemporary management of complex aesthetic dilemmas with an interdisciplinary approach</td>
<td>70</td>
</tr>
</tbody>
</table>
This report provides a summary of 16 principal sessions which took place at the EAO’s 25th annual Scientific Meeting. The report was written by a group of delegates at the meeting who have previously prepared similar summaries for circulation among their friends following past EAO meetings.

As described in the methodology, all speakers were given the opportunity to review and amend the editorial that had been written about their presentation, although a significant minority did not respond to the editors’ requests for feedback. The EAO wishes to emphasise that this is not a peer-reviewed scientific report. It was written by the team of volunteer delegates, albeit with input from a large number of the speakers represented. The contents do not necessarily represent the view of the EAO and readers are responsible for independently evaluating any information contained in the report. Nonetheless, the EAO hopes that the report will provide a useful and informative summary of the proceedings of its 25th annual Scientific Meeting.
Acknowledgements

The EAO would like to gratefully acknowledge the substantial work carried out by Lino Esteve and Alberto Salgado in writing this report. They were supported by David Esteve, Guillem Esteve, Javier Amigo, Juan Navarro, Sandra Ferri, Tatiana Fernández, Alfonso Díaz, Vicente Belvis and Andrés Valdés.

Methodology

The methodology underpinning this report is as follows:

1. A team of dentist delegates volunteered to write the report and arranged to attend all the sessions covered in it during the EAO’s 2016 meeting in Paris
2. They provided a draft summary of each presentation to the EAO, which arranged for a copywriting team to edit it. This was not a scientific editing process, and instead concentrated on grammar and consistency
3. The editors returned the edited contributions to the dentist delegates highlighting any questions they had
4. On receipt of responses to their questions, the editors updated the contributions, then forwarded them to each of the speakers featured, along with a request for a selection of their slides (selected by the writers)
5. Each speaker was emailed up to three times to request their feedback. The majority replied and supplied slides. Some speakers provided textual corrections but declined to provide copies of their slides
6. A small number of speakers did not respond to any of the emails sent to them, and as a result the editorial on their sessions has not been reviewed by them

Copyright

A number of speakers allowed a selection of their slides to be included in this report. Readers should be aware that copyright in any original content included in these slides remains the property of the speakers, and/or any other third-party copyright holders. These slides must not be circulated other than as part of this report, and should not be copied or reused without the express permission of the relevant speakers.
Decision-making on the basis of the level of disease: conservation versus extraction

Making the choice between conserving or extracting teeth is an everyday dilemma. Furthermore, the increasing popularity and reliability of dental implants means that implant-supported prostheses are often now considered comparable or even superior to natural dentition.

But this view is starting to change. High rates of long-term complications associated with implants are being reported, along with different inflammatory responses observed around implants compared with around natural teeth. As a result, the scales should tip back in favour of preservation of teeth. In this session, everyday decision-making processes were outlined from a strictly periodontal point of view.

Periodontal therapy or implant therapy? How do we judge when to select one or the other?

Giano Ricci

Is it worthwhile trying to save natural dentition in advanced periodontal cases? The speaker asserted that he is in favour of saving natural teeth, and only uses implant therapy when the prognosis of the tooth is hopeless.

It has been possible to predictably treat a variety of periodontal defects for almost 50 years. Techniques and materials have changed, but predictability remains dependent on the regenerative potential of the defect (Figure 1.1.1).

Natural teeth require the same conditions as dental implants to remain healthy: they must be stable; contained within an envelope of bone; and free from bacteria (Figure 1.1.2).

Based on his extensive clinical experience, the speaker outlined the SVI rule. He described the three conditions which make it worthwhile to perform regenerative periodontal therapy on a tooth:

- stability
- vitality
- intactness

If the tooth does not meet these conditions, a dental implant should be considered.


Figure 1.1.1

Figure 1.1.2
Deciding between conservation or extraction of periodontally compromised teeth with a questionable prognosis

Giovanni E. Salvi

Prognosis and treatment predictability
Some teeth can be treated predictably, and their prognosis is secure. Others have a hopeless prognosis and have to be extracted. In the middle of the spectrum are teeth with a questionable prognosis, and these were the focus of the presentation (Figure 1.2.1).

Periodontal intrabony defects can be successfully and predictably treated for up to 30 years. Basic periodontal treatment can transform a prognosis from initially doubtful to favourable. Depending on the case, these teeth may even be used as abutments for conventional prosthetic restorations.

Periodontal therapy should aim to eliminate pockets exceeding 6mm in order to avoid the progression of periodontal disease and tooth loss (Figure 1.2.2). Tooth loss in periodontal patients can be reduced significantly if good plaque control is maintained (Figure 1.2.3).

Teeth have higher survival rates than implants and lose less supporting bone over time. A 10-year follow-up clinical study has demonstrated that this is true for periodontally compromised patients, whether they are smokers or not.

The risk of implant loss in patients who are treated for chronic periodontal disease is 1.59 times higher than in healthy patients. In cases involving aggressive periodontitis, patients are up to 4 times more likely to experience implant loss. It has been demonstrated that a suboptimal treatment of periodontitis is related to a higher risk of peri-implantitis.

Conclusions
- wherever possible, the emphasis should be on preserving the natural dentition
- periodontal therapy should be successfully completed before implant treatment begins
- enrolment in regular supportive therapy should be encouraged
- periodontally treated teeth can be used as abutments for prosthetic restorations

5 Rasperini et al. J Periodontol 2014
6 Sgolastra et al. COIR 2015
7 Pjetursson et al. COIR 2012
Soft and hard tissue grafting: prevention and management of complications

In this session speakers reviewed the prevention and management of complications in three tissue augmentation treatments: soft tissue grafting, guided bone regeneration and autogenous bone blocks.

Prevention and management of soft tissue defects around implants

Jacques Malet

A treatment plan should be developed in reverse, working from the desired final outcome back to the initial situation. The prosthesis should be designed before an implant is placed, and an optimal position must be located before the implant is inserted. In the same way, the amount of soft tissue and bone volume required for a successful outcome should be calculated before surgical steps are taken. Unfortunately, however, most treatment plans do not include this diagnostic phase. This increases the likelihood of clinical problems arising after treatment, such as marginal tissue recession (Figure 2.1.1).

It is well-known that papilla levels depend mainly on the levels of interproximal bone at the adjacent tooth. Facial marginal mucosal levels, however, are affected by several other factors, including interproximal bone levels, peri-implant biotype, facial bone level, implant fixture angle, depth of implant platform, and level of first bone-to-implant contact1.

What are the causes of soft tissue complications?

Bone remodelling:

Soft tissue complications can arise as a consequence of bone remodelling, and usually become apparent some time after the implant has been placed. In one study, complications were measured in a series of 11 maxillary anterior implants and the average values were as follows:

- buccal bone height: 0.7–1.3mm
- buccal bone thickness: 0.4 mm
- facial soft tissue margin: 0.7mm

1 Nisapakultorn et al. COIR 2010
2 Cardaropoli et al. COIR 2006
GBR:

There is little data concerning the long-term success and stability of hard and soft tissues around implants following GBR procedures. It is thought that GBR does not completely prevent reduction of bone volume. Currently, only a few studies have assessed the stability of the augmented buccal bone, and a recent systematic review has concluded that soft tissues in these studies were not adequately measured.

Immediate implantation:

Acceptable aesthetic outcomes may be achieved with immediate implant placement (Type 1). Recession of the mid-facial mucosa is an aesthetic risk in cases involving Type 1 placement – higher than in early or delayed implant placement (Types 2 or 3) – and especially in cases with thin-tissue biotypes or socket wall defects.

Recessions measuring more than 1mm were present at 1–3 years in 9–41% of Type 1 implant sites. Additionally, two retrospective studies using CBCT detected no buccal wall in 36% and 57% of the sites. Recession continued during a 2–8-year follow-up period. The effect of gingival biotype on peri-implant tissue response seemed to be limited only to facial gingival recession, and did not influence interproximal papilla or proximal marginal bone levels.

How can we treat and prevent these complications?

The gold standard in preventing complications continues to be the connective tissue graft, which can achieve a mean defect coverage of 66%, 96% and 89.6% (Figures 2.1.2–4).

Using this well-known technique, four steps must be followed:

- the surface must be thoroughly decontaminated
- maximum blood supply must be preserved
- the donor site must be carefully selected
- surgical trauma must be minimised

Outcomes tend to be stable over time but implant surface coverage is unpredictable, especially where the position of the implant is non-ideal. The current focus is on limiting patient morbidity, but the risk of a poor outcome is reduced when a stepped procedure following the above guidelines is performed over time.

In a cross-sectional study looking at 24 immediately placed implants, 14 were re-evaluated using CBCT at a 7-year follow-up visit. Five of those evaluated showed no buccal bone over the implant surfaces. They presented a mucosal margin 1mm more apical in comparison to implants with intact buccal bone. No correlation was found between initial bone volume defects and bone dimensions at the 7-year follow-up.

Prevention of complications

Complication prevention is based on achieving an ideal balance between bone and soft tissue.

Prevention using GBR: early placement of implants (Type 2 or 3), combined with simultaneous GBR, is a proven protocol in the prevention of further defects, as GBR encourages soft tissue generation.

Prevention using immediate implantation: case selection is crucial. Thin biotypes should be avoided, and tissue volume should be overbuilt. In cases featuring thin biotypes soft tissue regeneration using GBR is recommended, along with a preventative connective tissue graft.

Residual defects should be corrected with connective tissue grafts.
Membrane exposure is the main complication that is reported in GBR procedures. It has the potential to significantly jeopardise the final result. Where membrane exposure occurs, the graft can become infected and the amount of augmentation finally achieved is seven times lower than in undisturbed sites. The literature shows a great variability in the incidence of this complication, ranging from 7–80%. In 3–15% of cases the graft became infected, and in 50% regrafting was required. Early membrane or graft exposure is often due to flaps that are poorly designed or too small, which in turn are responsible for poor clinical outcomes.

The speaker described his early experiences of GBR, when he was working alongside Dr Philip Boyne. At that time, GBR was performed with a titanium mesh and a mixture of autogenous intraorally harvested bone graft and bovine bone-derived biomaterial. At six months, the procedure resulted in 36.47% new bone formation, and 15.11% volume resorption6.

The speaker also discussed a more recent collaboration with Dr Istvan Urban, where the technique was performed with titanium-reinforced dense-PTFE membranes and a combination of particulated autogenous bone and anorganic bovine bone-derived mineral (ABBM). In a prospective case series of 25 patients, histomorphometric measurements of the augmented tissue revealed that 31.0% was comprised of autogenous bone, 25.8% of ABBM and 43.2% was occupied by marrow space7. In a recent long-term evaluation of the technique the mean vertical bone gain was 5.1 ±1.8mm, and was 7.0 ±1.5mm horizontally. No intraoperative or postoperative complications were noted 1–15 years after loading8.

As a result of this collaboration, a classification of flap designs has been proposed when performing vertical ridge augmentation in the atrophic anterior maxilla. The four clinical conditions proposed under this classification are:

1. Shallow vestibule with healthy periosteum
2. Deep vestibule with healthy periosteum
3. Shallow vestibule with scarred periosteum
4. Deep vestibule with scarred periosteum

The aim of this classification is to allow clinicians to achieve tension-free closure and more predictable vertical bone gain9 (Figures 2.2.1–4).

The speaker identified several guidelines that should be taken into account in order to reduce complications in GBR:

1. ample surgical access
2. tension-free flap
3. site preparation, graft selection and fixation
4. membrane selection and fixation
5. connective tissue graft
6. primary closure
7. post-operative care

He also outlined the following key factors on which the success of the techniques is based:

1. preventing the soft tissues collapsing into the defect
2. stabilising the particulate bone graft
3. protecting the surgical site against blood clots and osteogenic cells
4. excluding competing non-osteogenic cells and resorptive factors
5. suturing technique (double layer sutures)
6. surgical dexterity

---

How to reduce complications using autogenous bone blocks
Matteo Chiapasco

As clinicians, we are often faced with defects which may require bone reconstruction, such as:

- 3D defects in the aesthetic area (especially in high smile lines)
- atrophic posterior ridges in both jaws, where there is not enough room for short or even ultra-short implants
- extreme atrophy of the mandible, where there is risk of mandibular fracture
- severe atrophy of the maxilla, with no possibility of placing short or tilted implants

Several techniques have been described to reconstruct alveolar ridge width and height to resolve these issues. Autogenous bone blocks are one of the most successful techniques, and are widely considered to be the ‘gold standard’.

Are procedures using autogenous bone blocks successful?
There is evidence that autogenous bone blocks can be successfully used to augment horizontal defects using a two-stage approach. Using this technique, according to a recent systematic review, one study reported that a linear bone gain of 4.3mm can be expected at the time of implant placement, with a mean initial ridge width of 3.2mm. In cases involving vertical ridge augmentation, bone blocks produced a mean linear bone gain of 4.7mm when at least 4mm of vertical augmentation is needed.

The main complications associated with bone blocks are: wound dehiscence and graft exposure; infection and sequestration, or non-integration and even total loss of the graft; and late bone resorption. The mean complication rate is 6.3% in horizontal ridge augmentation (mainly graft exposure), but a high complication rate can be expected in vertical augmentation (graft exposure in 12.5–33.33% of cases; graft loss in 8–20%; mean complication rate of 8.1%)10.

Six tips and tricks to prevent complications (Figures 2.3.1–6)
1. Ensure there is adequate blood supply to the graft
2. Ensure adequate modelling and fixation of the block
3. Cover the bone block with slowly resorbable xenografts
4. Make releasing incisions for a tension-free flap
5. Do not load or compress the reconstructed area with removable provisionals
6. Wait for integration of the graft, and never place immediate implants

Conclusion
Due to morbidity, bone grafts should be limited to cases where less invasive procedures are not sufficient. It must also be remembered that a 100% success rate is unlikely, as there are risks involved in any surgical procedure. Reported complication rates vary greatly. Should the proven protocols be strictly followed, however, these rates can be limited.

10 Milinkovic & Cordaro. IJOMSurg 2014
RULE #3
Adequate fixation of the graft with close contact with recipient site

RULE #4
Fill any residual gap between graft and recipient site and cover the bone block with autogenous bone particles mixed with slowly resorbable xenografts

RULE #5
Stabilization of graft particles with resorbable membranes and water-tight and tension-free suture of the flaps over the reconstructed area

RULE #6
No load/compression by removable prostheses on the reconstructed area for at least 4–6 weeks after the surgery.
Maryland bridges, vacuform retainers, fixed provisionals with no load on the operated areas are OK.
After 8 weeks, in particular in fully edentulous patients, removable prostheses relined with soft materials are allowed.
A digital revolution

From diagnosis to planning and execution, treatment processes are becoming increasingly digitalised. The ability to create and place prosthetic restorations on both natural teeth and implants using a completely digital workflow is now a reality. This is having a profound effect on daily practice, and its advantages cannot be ignored. During this session, the speakers mapped out and assessed how far we have come with digital implant dentistry.

Virtual smile design to drive the restorative plan

Marcelo Calamita

Predictability and communication

Predictability is crucial in implant treatment. In 90% of cases, achieving a sufficient level of predictability depends on an accurate diagnosis and a suitable treatment plan which takes into account aesthetics, function, biology and structure. Communication is vital both between the patient and the clinician, and among the treatment team. Digital workflows allow all aspects of communication to be enhanced.

Currently, the main digital diagnostic tools are: CBCT, CAD/CAM, iOS and DSD. These allow us to make diagnoses, develop treatment plans, present cases and manage treatment. This makes our workflow with patients, colleagues and technicians much more effective.

Case 1, using Digital Smile Design (DSD)

When making up a treatment plan using DSD, the first step is to use a digital face-bow. The aim is to identify and relate facial landmarks – such as the glabella, philtrum and mentum – to reference planes, such as the eyebrows, interpupillary distance, or the interalar and intercommissural width. Once these have been identified, the facial/dental midline is marked, and the smile-line, interdental proportions and tooth outline can be determined. A digital ruler can help us configure the ideal parameters for this particular case.

One of the main benefits of using DSD is that the predicted final result, made using these calculations, can be shown to the patient before the treatment is started. Digital planning allows the operator to easily discuss the pros and cons of the proposed treatment with the patient, and outline in advance any potential limitations or compromises that may be encountered.

The speaker then described a clinical case which involved a severe volume defect in the aesthetic zone. The treatment, which included placing two implants, began with orthodontic extrusion, intended to make the gingival margins level. Next, hard and soft tissue grafting was performed; finally, a hybrid fixed prosthesis was placed, along with a prosthetic gingival reconstruction.

Case 2

This case involved a vestibular recession with an unaesthetic appearance caused by a poorly positioned implant at 11 which needed to be explanted. Following socket repair, three connective tissue grafts and extensive soft tissue conditioning, the case was completed using porcelain veneers and a single implant crown.

The speaker recommended that the initial treatment plan that is shown to the patient should be created in 2D. Once they have accepted the plan, the operator’s team and lab should be briefed. Only then can the plan progress and the clinician develop a solution in 3D, using either analogue or digital tools.
Digital dentistry has three main stages (Figure 3.2.1):

- **data acquisition** (involving registration, charting, photos or video being taken, facial scanning, intraoral scanning, model scanning, and CBCT)
- **planning/processing** (data-merging, implant planning, computer-assisted design)
- **fabrication/execution** (CAM via subtractive or additive procedures, and treatment itself)

Bone imaging using CBCT alone is not enough to complete the diagnosis, because it cannot convey key information about soft tissue and prosthetics. To complement the CBCT scan, intraoral scans and/or model scans should be used. The images gathered can be superimposed by means of fiducial markers to give more precise information about the relation between hard and soft tissues and the proposed prosthesis.

Data acquisition has two requirements: the prosthesis being used during acquisition has the ideal positions of the teeth; and fiducial markers are located to allow the two images (from CBCT and iOS) to be merged. In cases where the existing prosthesis is not ideal, a template should be fabricated with the ideal position of teeth as a point of reference.

The template can be created using either an additive or subtractive process. The subtractive process is fast, stable and accurate, but is unable to make undercuts or complex structures. Once it has been verified that the appliance fits, guided surgery can be performed reliably. The speaker cautioned that although it is a reliable procedure, it is limited by the fact that some deviation is inevitable during surgical navigation.

Different intraoral scanners employ different methods of scanning, using either light or laser technology (Figure 3.2.2). It has been estimated that results can vary by approximately 70μm, but the level of imprecision may be higher in cases involving edentulism. Other factors to bear in mind when considering intraoral scanning are:

- the greater the number of implants, the lower the accuracy
- the use of landmarks is strongly recommended
- mobile mucosa cannot be digitised

The next step involves virtual registration and mounting. One method consists of scanning the articulator with the casts already mounted, but a mechanical face-bow must be used. Alternatively, using a ‘PlaneFinder’ device, reference points can be located quickly and the procedure can continue in a fully digital environment, without the need for mounting plaster casts on a mechanical articulator.

The next problem is how to merge the soft anatomical structures. Combining 2D and 3D data can be useful for gathering information about how the teeth appear from the front, but it is of little help in providing information about lateral orientation and position, and is not a useful patient communication tool. This step must therefore be done using facial scanners.

Facial scanners can be static (3D) or dynamic (4D). The main applications of static facial scanners lie in plastic surgery, orthodontics and orthognathic surgery, although they have limited applications in prosthodontics. Information gathered by these scanners can be combined with CT or CBCT files by being superimposed over them.

Dynamic facial scanners use continuous photo-capture with 50 frames per second, but cannot be combined with CT or CBCT scans, as the latter are static and therefore incompatible. 3D-over-3D superimposition has the potential to be a valuable technique, but requires further simplification before it can be used in daily practice. CAM has multiple possibilities – one of the most interesting being the use of monolithic zirconia prostheses – although the lab technique to suitably mimic aspects of the tissue must first be mastered (Figures 3.2.3 and 3.2.4).

1 Van Assche et al. COIR 2012; Tahmaseb et al. IJOMI 2014 2 Patzelt et al. JADA 2013; Patzeit et al. COIR 2015
Conclusion

- The more data and information that is acquired, the more precise the rehabilitation will be.
- A completely digital approach is currently unavailable for complex rehabilitations.
- A combination of conventional and digital techniques can enhance communication and patient care.

- A major drawback is that the team must be experienced and well-trained.
- Future technologies have the potential to streamline the workflow and accelerate the manufacturing process.
How far we are with digital dentistry?
Throughout his presentation, the speaker emphasised that it is possible to perform many dental procedures supported by a range of digital tools that are currently available: the technology exists now. This extends to both restorative and non-restorative techniques.

Using CAD/CAM technology, we can obtain high resolution captures which can be used to develop the ideal design of fixed prostheses. This includes calculating margin location and adjustments, insertion axes and even the suitable colour and shade of the restored tooth. These CAD files can then be transferred to the CAM system to create prostheses rapidly and easily. The manufacturing process can use various materials and feature subtractive or additive processes. The speaker talked about how he was involved in an investigation to develop a new ceramic printing procedure. He described various cases involving partial fixed implant prostheses, outlining his planning process using CBCT, and illustrating how surgical guides can be digitally designed and fabricated using CAM, with two methods currently in use: milling or 3D printing. This technique allows for less invasive surgery and ensures that the implant is placed in the correct 3D position. He demonstrated how the CAM process can be utilised to allow increased precision, more detailed customisation of abutments and improved aesthetic outcomes.

He went on to describe various cases involving removable prostheses, and illustrated various steps of the treatment plan:

- use of the virtual articulator
- laser sintering of the metal framework
- CAM fabrication of a complete prosthesis

In aesthetic dentistry, digital tools such as intra- and extraoral photographs, intraoral scanners, and colour assessment tools can help clinicians perform better facial and dental analyses. This data can be used to design CAD-based restorations and create digital wax-ups. These can be used to evaluate the final outcome digitally before physically placing the prosthesis. If the patient is satisfied with the proposed solution, the treatment can be carried out.

The speaker also mentioned several promising non-restorative computer-assisted applications, which can monitor tissue recession, wearing or changes in volume with great precision.

3 Silva et al. J Prosthodont 2010
40,000 implants down the road: What did we learn?

This session featured speakers from the Brånemark Clinic in Gothenburg, Sweden, and reviewed what they have learned over a period of 30 years, during which over 40,000 implants have been placed at the clinic. Their experience clearly demonstrates the effectiveness of dental implants, which have proved to be stable and predictable for the majority of patients over three decades. Nevertheless, failures and complications can and do occur. This session explored some of the causes behind these complications and failures.

Some thoughts on ailing and failing implants

Bertil Friberg

Failures and complications: where can we find the causes?
Four potential sources of failures and complications can be identified:

- **components**: the devices and materials used or the ‘hardware’
- **technique**: how treatment is carried out or the ‘software’
- **performer**: the clinician’s attitude, experience and skills
- **patient**: the recipient’s bone and systemic conditions

**Components**
Since moderately rough surfaces were introduced in 2003, the incidence of early implant failure has fallen from 2.5% to 1.5% in the mandible and from 9.3% to 1.8% in the maxilla. The use of tapered implant designs (like the Mk IV) allowed for increased primary stability, which is beneficial when placing implants in soft bone or during immediate loading protocols.

**Surgical technique**
The use of longer and angulated implants has also improved outcomes. In addition, for systems such as the standard Brånemark implant the final drill diameter used in the osteotomy can be reduced, achieving higher insertion torque and implant stability quotient (ISQ) values, leading to increased primary stability. Failure rates are low among straightforward cases, but levels were found to be significantly higher in more complex cases involving advanced surgical techniques (Figure 4.1.1).

**Performer: surgeon competence and performance**
A 28-year study of 11,074 procedures analysed the impact of the surgeon on the outcomes. Factors that can influence early implant failures were found to include:

- individual surgeons’ level of experience
- surgeons’ attitude and self-confidence
- whether structured routines or clearly defined protocols were in place
- co-operation of the surgical team

2 Friberg et al. IJOMI 1991

Having failures, one may search for reasons amongst used techniques: Yes!

![Immediate insertion; direct loading; zygoma](Image)

Figure 4.1.1
Complex cases and poor support were also associated with higher stress levels, which led to higher rates of intraoperative complications and early failures.

**Patient**

There are three key stages at which patient-related factors can influence the likelihood of an implant failing:

- **Placement**, resulting from poor bone quality and/or volume
- **The establishment of osseointegration**, resulting from non-optimal systemic conditions
- **Post-operative maintenance**, such as the build-up of biofilms due to poor dental hygiene

**Poor bone volume and quality**

A variety of treatment approaches have been suggested to address situations where there is insufficient native bone. These include augmentation using bone grafts or bone blocks, or the use of short implants. These procedures have more risks associated with them than conventional treatment (Figure 4.1.1).

Severe general and local osteoporosis has been identified as a potential obstacle for osseointegration, especially in extreme conditions where jaws appear empty and have no visible internal bone structures on radiographic scans. Conversely, several studies have concluded that osteopenia did not contribute to implant failures⁴.

Nevertheless, clinical problems are not caused by poor bone volume or low bone density alone. A combination of the two is often what leads to complications. This is especially the case when immediate loading is involved (Figure 4.1.2).

**Systemic bone disease and age at surgery**

Patients with systemic diseases affecting mesodermal tissues (bone, cartilage, or connective tissue) can often benefit from successful implant treatment. Such diseases include of X-linked hypophosphatemia; Langerhans cell histiocytosis; lupus; scleroderma; and osteogenesis imperfecta. Case reports with 15 years of follow-up have demonstrated good survival rates in such cases⁵.

Patient age alone is not an indicator of the likely success or failure of implant treatment. Tooth loss has been cited as an independent predictor of mortality in the population. Younger patients who have lost many or all of their teeth are therefore generally associated with a higher risk of systemic problems. Accordingly, a number of younger patients contributed to the overall number of total implant failures and bone loss after 5 years in the case series being discussed⁶.

**Persistent bone-level biofilms**

Many early implant losses are due in part to overheating in dense bone caused by poor drilling technique or bone compression following insufficient preparation or self-tapping. Another possible cause seems to be the re-emergence of a latent infection, which may then spread rapidly around the implant and cause failure. In other cases, infection can lead to development of a fistula, also known as apical peri-implantitis. Kassolis and colleagues found that such conditions may originate in regions of necrotic bone and consequent subclinical infection, leading to early implant failure⁷. They carried out a histopathologic study on 154 bone samples obtained during implant osteotomy preparations from both jaws. Regions of microbial biofilm formation and non-viable bone were discovered after as little as one year following tooth extraction and mucosal healing. They concluded that these findings may contribute to the development of osteonecrosis of the jaw and early implant failure. In post-extraction alveolar bone which had apparently healed, the persistence of bacterial biofilm has also been discovered following microbiological analysis⁸ (Figure 4.1.3).

---

7 Kassolis et al. Bone 2010
8 Nelson & Thomas Clin Implant Dent Rel Res 2010

---

Thus…

..it is not poor bone volume per se!

..it is not the poor bone texture per se!!

..it is the combination of the two that implies problems!!

..and especially so when handling immediate loading!!

---

Bone loss due to self-tapping implants/surgical technique?

- bone compression
- over-heating
- revival of latent infection (main reason for early losses!!!!!)

---

Figure 4.1.2

Figure 4.1.3
**Maintenance of osseointegration: peri-implantitis**

The diagnosis of peri-implantitis continues to be controversial. Bleeding on probing is not a reliable parameter for marginal bone loss. Probing pockets can be similarly unreliable, as the depth of the peri-implant sulcus may depend on a number of factors:

- implant position
- abutment length
- mucosal swelling

A radiographic evaluation of bone level over time remains the most reliable tool for identifying implants undergoing continuous bone loss.

At the sixth European workshop of the European Federation of Periodontology (EFP) in 2008, it was stated that there was limited evidence that the proposed surgical and non-surgical treatments could resolve a significant proportion of peri-implantitis lesions (28%–56%). A more recent clinical study concluded that oral hygiene treatment and/or surgery to combat peri-implantitis did not reduce the implant failure rate or marginal bone loss recorded in the 88 treated patients, when compared with non-treated patients.

**Were success rates higher in the past?**

A clinical review currently being conducted highlights some circumstances which may explain the higher survival rates and lower complications registered in earlier decades (Figure 4.1.4). These can potentially be attributed to a variety of factors. Implants are now used for a much wider range of indications, and surgical procedures have become more advanced, pushing the boundaries of what is possible and in some cases increasing the level of risk. Additionally, some new components such as aesthetic abutments have been associated with higher levels of bone resorption. There is a trend towards more biological complications associated with more complex cases, and a correspondingly greater risk of failures.

**Teeth vs. implants**

1-year survival rates are marginally better in cases involving restored teeth than those involving implants (Figure 4.2.1). However, predicting long-term outcomes based on short-term results – and assuming these results will remain linear – is not a reliable procedure. The table in Figure 4.2.2 demonstrates that we can reasonably expect single implants to have a better long-term survival than restored teeth in routine practice (Figure 4.2.2).

**Are we over-estimating peri-implantitis?**

In a 9-year follow-up study of 145 patients previously identified as having progressive bone loss and peri-implantitis, the progressive bone loss previously reported could not be confirmed. Implants classed as both ‘affected’ and ‘unaffected’ exhibited the same mean bone loss during follow-up. Moreover, initial bone loss cannot be considered a predictor for future bone loss or increased risk of implant failure.

This challenges the claim that all patients identified with peri-implantitis should undergo surgical treatment. The results of the above study indicated that patients who were treated showed slightly more bone loss at the 9-year follow-up than those who

---

4. Fransson et al. COIR 2008

---

**40,000 implants down the road: what did we learn?**

**Torsten Jemt**

**Effectiveness and efficacy**

The speaker began by describing how data on 11,600 patients and 50,700 implants has been gathered from both the Brånemark Clinic in Gothenburg (relating to public dental care), and from a private referral clinic. The data covers the period when osseointegration was still a controversial topic, continuing right up to the present day. Rather than being based on prospective randomised studies that have been carried out under strict conditions, it reflects the effectiveness of implant treatment as delivered in routine general practice. He asserted that in his opinion the ‘real world’ nature of the data made it more relevant than data obtained from RCTs.

**Teeth vs. implants**

13 Rothwell PM. Lancet 2005
14 Fransson et al. COIR 2008
were not treated. However, these observations need to be analysed further.

**Risk of biological complications: calculating the odds ratio/hazard ratio**

In an unpublished study by Antoun, Jemt, et al.\(^\text{16}\), significant risk factors for inflammation (p < 0.05) were analysed using a multivariate logistic regression model in a clinical series of 1,592 operations from 2000–2011. An odds ratio (OR) for early inflammation and hazard ratio (HR) for peri-implantitis were calculated, with the following conclusions:

- the number of implants is linked to the level of associated disease (more implants = more teeth lost = more systemic/local factors)
- a history of periodontitis was a strong predictor of the occurrence of peri-implantitis between 0.4–1.4 years after treatment, but not later
- smoking doubles the risk of early and late complications
- with regard to patient age at the time of surgery, the OR for early inflammation was at its highest at 53 years
- complex surgical techniques involving grafting; the use of membranes; and one-stage and immediate implantation lead to an increased OR for early inflammation and HR for peri-implantitis. This is probably because complex procedures could introduce more foreign bodies to the surgical site
- the risk of peri-implantitis increases as the year of treatment progresses from 2000–2011

The data suggests that the presence or absence of peri-implantitis is linked to multiple factors, such as the nature of the individual’s physiology and the surgical technique adopted. In addition, it has also been postulated that some patients may have a genetic predisposition to inflammation associated with tooth loss.

**Incidence of implant failures**

In a 27-year retrospective study\(^\text{17}\) of 8,528 consecutive cases involving 39,077 implants, 9.8% resulted in failures. Most of these failures were early and related to the same patients. The marked difference between jaws disappeared when moderately rough surfaces were used. When comparing results at 10- and 27-years, higher rates of failure in the following cases were no longer evident:

- the upper jaw
- turned surfaces
- partially edentulous patients

When the follow-up was extended from 10 to 27 years, incidence rates became balanced, and curves became parallel (see Figure 4.2.3).

**Odds ratio/hazard ratio for early and late implant failures**

Smoking was seen to double the incidence of both early and late failures.

\(^{16}\) Antoun, Jemt et al. 2016, in manuscript

The risk of failure could also be linked to surgical techniques. Immediate implants; cases involving grafting; and one-stage procedures all had a higher OR/HR for both early and late failures\(^\text{18}\).

The speaker used examples of different clinical variables to demonstrate how a range of risk factors can impact implant failures:

- **scenario 1**: an immediate implant is placed by the year 2000 in a smoker, with simultaneous grafting surgery
- **scenario 2**: a non-smoker receives an implant by the year 2010 using a two-stage surgical protocol without immediate grafting

When the four factors were simultaneously present (scenario 1) the risk of failure rose to 36.5% and when none were present (scenario 2) it fell to 0.4%.

**Why are there such differences in failures?**

Younger edentulous patients exhibit higher mortality rates, whereas older patients have a lower mortality rate compared with the general population. This observation seems to reflect variations in general health, which may be more compromised in the younger group than in the older.

Further, younger edentulous patients with implant failures show a higher mortality rate than other implant patients of comparable age. The same is true for older patients. These patterns signal a systemic problem, leading to an impaired osseointegration response. Osseointegration is, in the end, a foreign body response which is regulated by the immune system.

**Incidence of peri-implantitis and peri-implantitis surgery**

The risk of developing peri-implantitis was found to be significantly higher (p < 0.05) in the lower jaw; following more advanced surgical procedures; and in cases treated towards the end of the period 2000–2011\(^\text{19}\). Differences in patterns of results between the two clinics could potentially be due to the different choices of surgical techniques used in the different settings.

Analysis of data relating to patients who received public dental care in the Västra Götaland region showed that of 423,000 adults examined in 2014, 2.5% (10,603) had received implant treatment. The mean incidence of peri-implantitis was 7.3%. Only 13.7% of those previously diagnosed with peri-implantitis – 1% of the total implant patient cohort – underwent peri-implantitis surgery. These findings suggest that the prevalence of peri-implantitis depends on how we define the problem. Furthermore, the evolution of the condition is unpredictable with or without surgical treatment.
Conclusions from 1979 to the present
- we are now more aware of the role of the immune system in how patients respond to implant treatment. Systemic elements have to be taken into account
- generally speaking, conservative techniques are safer and involve fewer failures. One-stage immediate implantation and simultaneous grafting increase early- and late-stage risks
- we can identify different patterns and levels of complications in different routine practices. It is likely that these differences relate to who decides which patients to treat and what procedures they receive
- there is a trade-off between more complex procedures that can yield optimal aesthetic results and increased risk of complications (Figure 4.2.4)

Figure 4.2.1

Figure 4.2.2

Figure 4.2.3

Figure 4.2.4
Contest by the Junior Committee: ‘7 minutes to convince’

An original concept to present new research in implant dentistry

The session featured seven ‘out-of-the-box and original’ presentations which each lasted seven minutes. At the end of the session the audience and the Junior Committee voted for the best presentation.

Digital working in implantology (parts 1 and 2)
Karim Dada and Leon Pariente

The digital generation
Implant treatment should ideally be simple to execute and provide an excellent aesthetic outcome. To achieve this, we must carefully manage the treatment process from start to finish. Digital technologies currently provide the best tools for achieving ideal 3D placement of implants (Figure 5.1.1).

Once information about the morphology of the teeth and tissue has been digitised it can be converted to a digital model, and a diagnostic wax-up created. Smart Fusion technology1 can combine CBCT-based data with stereolithographic surface data of the cast from 3D optical scanning. This allows us to visualise the gingival margin of implant sites while using the software for planning, enabling ideal 3D positioning of the implant shoulder. The digital plan is then transferred to the surgical setting using tooth-supported stereolithographic templates. Thus simplicity, efficiency and predictability can be assured every time.

Positional inaccuracies can compromise aesthetics
Positional inaccuracies during implant placement can significantly compromise aesthetic outcomes in the anterior maxilla. It has recently been shown that guided implant surgery may increase the predictability of favourable emergence profiles and soft tissue aesthetics assessed by the PES (Pink Esthetic Score)2. The speakers are in the process of publishing a 22 patient series involving 33 implants using image-fusion stereolithographic templates and PES evaluation which supports these findings (Figure 5.1.2).

Strategic extraction protocol (SEP)3
Patients with failing dentition are now demanding implant-supported restorations without the use of an interim removable denture. To facilitate this transition, a strategic extraction protocol (SEP) can be applied. SEP goes a step beyond the ‘dual scan protocol’ as it allows prosthetically driven planning of the implants without the use of a radiographic scan template for the CBCT. Specific hopeless teeth are used as abutments to stabilise the surgical guide. They are then extracted in the same surgical session before the installation of the final fixed prosthesis (Figure 5.1.3).

---

1 Smart Fusion. Nobel Biocare Services Inc.
3 Dada et al. J Prosthet Dent 2016
The conometric concept to make fixed implant-supported restorations

Marco Degidi

Avoiding problems associated with cement and screws

Cement- and screw-retained restorations have limitations, and are prone to both biological and technical complications. The speaker proposed a novel approach for constructing fixed restorations which may avoid these problems: the use of conometric abutments.

With this approach, retention is achieved via the conical interface – or ‘coupling’ – between abutments and copings. Conical coupling can only occur when the coping is fully seated on the abutment, which is done by gently tapping it (Figure 5.3.1). Its retentive strength has recently been studied in vitro and found to be comparable with – and sometimes superior to – values reported for commonly used temporary cements. The strength of the retention increases with larger abutment diameters and higher head heights.

Conometric retention has the potential to provide a reliable connection between abutments and fixed prostheses without the need for cement.

When should we use it?

Conometric retention can be used in single, partial and full-arch cases and is compatible with virtually all prosthetic materials (acrylic, metal-ceramic, lithium-disilicate and zirconia). The method can also be used for immediate and delayed loading, and can be incorporated into a digital workflow. In cases involving two or more implants, good parallelisation among the abutments must be achieved.

The margins of the restoration can be as deep as required, as there is no gap or cement. This allows the emergence profile to result from the design of the crown or bridge sculpting the soft tissue. This concept is the opposite of digitally designed anatomical abutments.

This novel approach allows easy removal of the prosthesis for maintenance by means of a spring bridge remover. It can then be tapped back into position. The removal can only be performed by the dentist (Figure 5.3.2).

In conclusion, the advantages of this new method of prosthetic retention are:

- it is highly precise
- the procedure is simple
- it offers a reduced treatment time
- it provides good passivity
- it is reliable
- it is repeatable
- the cost is not prohibitive

4 Nardi D. Int J Prosthodont, 2017 in press
A customised solution for 3D defects

Giuseppe Lizio

Standard solutions for treating 3D defects have limitations, and can often prove difficult to apply, partly because each defect and patient is unique. Treatments should therefore be customised to meet individual patients’ requirements.

The current approach
The anatomical site and the dimensions and morphology of bone defects can influence both the approach and outcome of a grafting procedure:

- **autogenous bone blocks**: the graft should be oversized to counteract the associated high rate of resorption. Further, autogenous bone blocks are difficult to fit and properly fix to the defect, requiring a large amount of bone
- **titanium mesh in GBR procedures**: Ti meshes ensure adequate space; hold the particulate graft material in place; and provide support for the overlying soft tissues. Good results can be obtained in terms of bone volume, and high implant success rate have been reported.

6  Lizio et al. IJOMI 2014

The new approach
Customised meshes produced using CAD/CAM may reduce surgical time (Figures 5.4.1 and 5.4.2). The speaker described the procedure used during his recent trial of CAD/CAM produced titanium meshes:

- virtual 3D models of the alveolar defect were constructed with dedicated CAD software using data from CT scans
- each mesh was digitally designed to fit the bone perfectly, so that further modifications would not be required
- meshes were printed with a laser sintering technique and were applied directly to the surgical site
- preliminary results are encouraging

Compared with other augmentation techniques, this procedure has three advantages:

- surgical time is reduced
- less bone harvesting is required
- the learning curve is shorter

Good levels of bone gain can be achieved if proper management of soft tissue is performed.

---

Figure 5.4.1

Figure 5.4.2

- Complications
- Bone regeneration
- Implants' results

Congress Scientific Report, Issue 2, February 2017
Effective implant surface decontamination during peri-implantitis treatment: what is the secret?

Brenda Mertens

According to conclusions drawn in the consensus report of the 6th Workshop on Periodontology, the key to success in treating peri-implantitis is the chemical and mechanical decontamination of implant surfaces. This is a prerequisite for the elimination of biofilms. A technique to do this which preserves the structure of the implant; is biocompatible; easy to use; and cost effective is required.

The speaker summarised the results of a systematic review of the methods currently used for implant decontamination when treating peri-implantitis which do not harm implant surfaces (Figure 5.5.1). Results were categorised by type of implant surface and treatment approach, with colours indicating their success. The authors of the review analysed the three techniques that are most effective for all surface types, and proposed a unique protocol which is valid for all situations (Figure 5.5.2):

Stage 1 – mechanical:
- curettes for removal of granulated tissue
- use of air powder abrasive or titanium brushes or Er:YAG laser

Stage 2 – chemical:
- treatment with cotton pellet soaked with chlorhexidine 0.2% or hydrogen peroxide 5%
- rinsing with saline solution

Point of view perspective of a dental implant patient

Mustafa Ozcan

It may seem unusual for a dentist to put him or herself in the place of the patient, but it is a practice that we may all benefit from. The speaker showed a video filmed from the point of view of a patient, illustrating what they were seeing and experiencing during implant surgery. The footage showed what the patient saw at different stages during the treatment, and displayed heart rate readings while processes such as milling or suturing were carried out.

The speaker is currently conducting a study comparing patients’ preoperative anxieties to postoperative pain by means of a visual scale questionnaire (VAS). The results highlight a significant correlation between anxiety and pain: the more anxious the patient was before surgery, the more pain they experienced afterwards.

The film showed interviews with two patients who experienced different levels of preoperative anxiety. It concluded that patients are unique, experiencing different emotions throughout treatment. Being aware of patients’ perspectives and keeping their personal experiences in mind means we can adjust our behaviour to improve the subjective aspects of treatment and patient satisfaction (Figures 5.6.1 and 5.6.2).
Voids and areas of reduced mineralisation in healed sinus grafts: a prospective study using immediate and 6 months’ cone beam computerised tomography

Amandine Para

Previous studies reviewing sinus augmentation have provided histological information; data on rates of implant survival; and/or quantitative evaluations of the volume of bone obtained after grafting.

It is common to find voids or areas of reduced mineralisation following these procedures, however, but this is not reflected in the studies (Figure 5.7.1). The speaker presented a study examining the qualitative radiological changes in augmented bone after a 6-month healing period. The methodology compared postoperative CBCT scans with a CBCT scan taken up to 6 months after the graft was placed. Different image patterns were found, and were classified into four groups (A, B, C and D) (Figures 5.7.2–5.7.5).

In 22% of the cases – groups C and D – CBCT images revealed an irregular pattern in the graft, showing voids and zones of radiolucency. These defects were not caused by poor compaction of the material but by defective bone formation in some areas.

In 4% – group D – the graft was non-homogeneous and had an irregular, disordered pattern. The speaker speculated that a postoperative haematoma or infection could have generated tissue granulation instead of bone formation.

Results

At the end of the session, Mustafa Ozcan won the audience vote. You can watch his video on patient points of view on YouTube:

https://tinyurl.com/j8dxoym
Treatment planning session: a clinical case with a ‘complex’ problem or involving extensive rehabilitation

Two teams of three clinicians – each specialising in a different area of implant dentistry – discussed a complex case presented by the moderator. Details of the case, which had been selected because of its complexity and scope for a multidisciplinary approach, were circulated to the participants before the session.

After an initial presentation of the patient data, both teams proposed their treatment plan and described their decision-making process to support it. This gave the audience an insight into how comprehensive and interdisciplinary treatment plans can be developed. A team from North America and a team from Europe each discussed the approach they would take.

Case presentation

**Session coordinator: Stefano Gracis**  
**Session moderator: Michael Cohen**  
**Case presenter: Andrea Ricci**

The patient is a 54-year-old male with severe chronic periodontitis. He is partially edentulous; has difficulty chewing; complains of mobility of his frontal teeth; and wants to improve his smile. Radiographs taken during his first consultation show generalised bone loss which is mostly horizontal (Figures 6.1.1–6.1.3). He has a history of periodontitis, and had three implants placed three years ago (Figure 6.1.4). The patient’s periodontal charts can be seen in Figures 6.1.5–6.1.6.
The clinical decision-making process for extraction and implant placement

Team North America: Sonia Leziy, Brahm Miller, Drew Ferris

Evaluating the problem

An important factor to bear in mind from the outset is that the patient wishes to keep as many teeth as possible. There are several questions which need to be answered as part of the initial decision-making process:

- what treatment options can fulfil long-term functional and aesthetic requirements?
- can the natural dentition be maintained, or should implants be considered?
- how good is the patient’s oral hygiene?
- is the patient sufficiently motivated and committed to long-term maintenance? Will this affect the success of the treatment?

After an inter-disciplinary diagnostic review which took restorative, periodontal, orthodontic and occlusal aspects into account, the team focused on risk factors. They emphasised that this step is crucial as it determines the likelihood of disease redevelopment.

Risk factors were categorised as:

- biologic/environmental
  - advanced periodontal disease
  - prior implant failures
  - malocclusion and lack of posterior support
- behavioural
  - poor oral hygiene and high bacterial burden/biofilm
  - potential challenges to adhere to long-term therapy
- financial/personal
  - motivation and financial situation
  - ability to meet patient’s aesthetic expectations
- health/genetic
  - disease predisposition (IL-1 phenotype, stress, male gender, diet)

With regard to the patient’s motivation and financial situation, we must ensure that he understands the condition fully and that we manage his aesthetic expectations. Finally, health risks should also be taken into account, especially any genetic disorders.

Following an interdisciplinary patient evaluation, the teeth should be analysed individually. The prognosis of each tooth should be classified as either: favourable, questionable, unfavourable or hopeless. This will help decide whether to conserve or extract (Figure 6.2.1). Making an evidence-based decision is difficult, however, as there is currently no standardised and meaningful system in place for classifying individual teeth.

Options for the maxillary arch (Figure 6.2.2)

1. Extraction of all teeth, followed by an implant-based restoration
2. Conservation of teeth using periodontal and orthodontic treatment, followed by posterior implants or a removable prosthesis

The rationale behind each option

Option 1 – for:

- the patient presents with advanced periodontal disease
- extraction simplifies the process of aesthetic rehabilitation
- anticipated costs are lower than for other options

Option 1 – against:

- the patient has indicated that he would like to keep his teeth; extraction goes against this
- the risk of peri-implant diseases will persist if the patient does not comply with long-term maintenance

Option 2 – for:

- this option complies with the patient’s wish to preserve teeth
- if a posterior support can be established, function will improve and secondary occlusal trauma will be eliminated

Option 2 – against:

- treatment is prolonged and extensive
- removable prostheses can be associated with: endodontic risks; poorer aesthetics at the tissue-teeth interface; and greater complexity involved with the perio-prosthesis

- peri-implant disease risk

Discussion of option 1 (Figure 6.2.3)

It is widely accepted that tooth mobility can be indicative of bone level deterioration in the near future. Therefore, after an initial period focusing on reducing plaque burden and assessing patient compliance, it was proposed that all remaining teeth be extracted. The restorative solution may then involve All-on-4 or -6 implants. Alternatively, the use of segmental bridges on 8 implants was also suggested. This solution has a greater distal span, but involves sinus grafting. Screwed prostheses requiring pink ceramics would be used to allow retrievability. There is currently a lack of consensus regarding the management of mobile teeth. Fuzzy logic has been proposed as an appropriate means of handling imprecise values like this.

1 Samet & Jotkowitz. Quintessence 2009

Discussion of option 2 (Figure 6.2.4)
Periodontal surgery in conjunction with orthodontic treatment has the potential to improve bone levels through tooth alignment; improved force distribution; improved crown to root ratios; and diminished mobility. An interdisciplinary orthodontic-periodontic-implant-prosthodontic approach could drastically improve function, aesthetics, occlusion and periodontal condition.

Option 2 aims to conserve and is predicated on:

- no extractions
- periodontal therapy followed by reassessment
- placement of implants in posterior zones using sinus grafting
- orthodontic aligner therapy
- polymethyl methacrylate (PMMA) provisional restorations, either individualised or splinted
- a final prosthesis

A preoperative aesthetic risk assessment (ERA) is highly recommended during this procedure to improve communication and prevent misunderstandings with the patient.

The orthodontic objectives of this approach are to:

- intrude the anterior teeth to reduce occlusal forces, which will contribute to more predictable restorations
- take a conservative approach to tooth preparation
- achieve a favourable inter-incisal angle using lingual root torque; this would result in less force and better function
- correct the patient’s midline and class II malocclusion on the left
- align the teeth to manage the space for future ideal restorations

In this case the use of aligners instead of traditional braces is preferable, as they are associated with improved patient acceptance and a periodontal environment which is easier to maintain. Aligner therapy offers distinct advantages for patients treated at a distance (Figure 6.2.5). Provisional PMMA restorations would be used, as they offer the opportunity to refine occlusal adjustments, and the prosthesis design can be checked with the patient. In the end the speakers decided to treat with option 2, and their plan is outlined in Figure 6.2.6.

5 Dawson & Chen. The SAC Classification in Implant Dentistry. Ed. Quintessence, 2009

---

**Figure 6.2.1**
- favourable
- questionable
- unfavourable
- hopeless

**Figure 6.2.2**
- maxillary arch proposal
- option 1
  - all teeth extraction & implant based restoration
  - periodontal disease advanced
  - fixed partial denture (FPD) or implant 13-11 (or implant 12). dentition. trans-Zr .5 wall. implants screw-retained monolithic zirconia
  - provisional PMMA restorations . individualized or splinted if necessary for mobility
  - 3 month SPT & aligner retention
  - long term PMMA provisionals - dentition & implants
  - orthodontics. aligner treatment

**Figure 6.2.3**
- orthodontic aligner therapy
  - clear aligner patients show superior overall periodontal health
  - controlled oral hygiene combined with perio treatment create favourable clinical attachment
  - can tailor appointment frequency depending on patient desires
  - painless effect
  - improved case acceptance

**Figure 6.2.4**
- orthodontic aligner therapy
  - patient does not want to lose teeth
  - extensive/lengthy treatment/partly removable sol’n
  - tissue/teeth interface aesthetics, endodontic risks

**Figure 6.2.5**
- provisional PMMA restorations - individualized or splinted if necessary for mobility
  - definitive restoration for aesthetics/function

**Figure 6.2.6**
- definitive restoration for aesthetics/function
  - PMMA reinforced provisionals 33-43
  - bone graft/posterior implants & flap curettage
  - initial therapy /OHI/reevaluation/treatment partial denture
  - maxillary arch treatment phases
Clinical decision-making process

Team Europe: Rino Burkhardt, Jörg Strub, Marc Schätzle

**Prognosis**

The patient’s concerns and wishes must be addressed from the outset. First, a pre-therapeutic prognosis must be determined for each individual tooth. However, this is an area of controversy as practice currently varies between dentists and depends on their individual preferences. This lack of clarity is due to the relatively imprecise definition of hopeless teeth. To further complicate matters, it has been shown that regenerative therapy has the potential to change the prognosis of hopeless teeth.

During the initial phase (which focuses on improving oral hygiene) pocket depth and tooth mobility are considered to be prognostic indicators. Before treatment can progress to the corrective phase, a re-evaluation must be performed to demonstrate that pocket depth and bleeding have been reduced, and that measures to control plaque have been effective.

**Orthodontic phase**

The aims of the orthodontic phase were to:

- align the upper dental midline to the facial midline
- intrude anterior teeth by 4mm to the cementoenamel junction (CEJ)
- correct torque in the upper incisors

To achieve these aims, the speakers proposed using fixed appliances and a palatal implant for reinforced anchorage.

If the periodontitis proves to be uncontrollable, intrusion could lead to further breakdown of the alveolar bone. Conversely, if the long junctional epithelium is healthy, intrusion can result in the coronal displacement of attachment levels and result in better distribution of forces throughout the teeth.

A palatal implant would provide absolute anchorage while distalising teeth 24–23 by about 4mm until class I malocclusion could be reached. Palatal implants have been shown to have a statistically significantly lower risk of failure than mini-screws.

During the meantime, two implants could be placed in each upper posterior quadrant (Figures 6.3.1 and 6.3.2). In the lower arch, the use of a removable bite plate was suggested to move tooth 37 to an upright position and reduce wobbling in the lower incisors.

**Prosthetic restoration**

There is no clear evidence as to when this stage should begin. A review of the literature only revealed case reports with vague and varying recommendations:

- 8 weeks after removal of the active appliance
- once adequate retention is obtained
- after approximately six months

Retention could be achieved using a fixed appliance placed during the prosthetic phase or with bonded stainless steel retainers. In the meantime, implants in the mandible could be placed, combined with lateral soft tissue augmentation.


9 Schätzle et al. COIR 2009

---

**Figure 6.3.1**

Treatment Planning – upper jaw
- Insertion of endosseous implants in the upper jaw
- Insertion site determined by the subsequent use of the implant as a prosthetic abutment
- Positions within the alveolar process and number of implants selected by the reference of prospective final tooth position
- Tooth 15 in Cl. I position will be maintained
- Teeth 23 and 24 will be distalized approximately 4mm into Cl. I relation

**Figure 6.3.2**

Treatment Planning – upper jaw
- Insertion of endosseous implants in the upper jaw

**Figure 6.3.3**

Treatment Planning – lower jaw
- Relieve incisors from jiggling
- Uprighting 37 by means of a removable biteplate at a later time point

---

Congress Scientific Report, Issue 2, February 2017
Case completion

At the end of the session, the moderator revealed the actual course of treatment, which had involved extraction of the maxillary teeth and use of an implant-supported total prosthesis in the upper jaw.

The planning stage had started with a digital smile design process. This ensured that the patient’s midline, incisal length and occlusal plane were correct from the early stages of the treatment, and would fit the smile line and the face. This process was also used as a communication tool to allow the patient to better understand the treatment objectives. The moderator emphasised that the patient was informed of the risks, and was fully compliant.

After an initial period of non-surgical periodontal therapy followed by a re-evaluation appointment, the prognosis was:

- poor for all maxillary teeth, as well as the upper implant
- fair for mandibular anterior teeth
- good for right posterior implants and the mandibular left molar, providing a root separation procedure

Full extraction of the maxillary teeth was performed and eight implants were placed in the extraction sockets. After six months, a second surgical phase was observed to gain access to the implants. A full upper arch provisional was delivered after tissue healing. During the osseointegration phase of the maxillary implants, implants were placed in the edentulous sites in the mandibular arch. At the patient’s six month re-evaluation he was satisfied with function, but complained (as expected) of some food trapping and difficulty in pronouncing ‘F’ sounds. The final treatment plan was therefore confirmed in favour of a maxillary implant-supported overdenture. A few months after delivery of final restorations, the patient expressed a desire to reduce the black triangles between the mandibular anterior teeth. He requested a minimally invasive treatment. Reshaping of the mandibular anterior teeth was performed by means of direct composite restorations.

Treatment remains stable after nine years. To date, the only modification required has been the recent replacement of the acrylic resin and upper teeth since the old ones had become worn.

Conclusion

- the same case can be treated in a variety of ways; more than one approach can often achieve clinical success
- the patient’s needs, wishes and levels of commitment must be taken into account
- we should be aware of our own clinical expertise and technical limits in order to develop an evidence-based treatment plan that is within our capabilities
- every step must be planned carefully, including placement of temporary prostheses and overall timeline
- potential risks should be considered and shared with the patient
- the treatment plan should be discussed in detail with the patient, and they must give informed consent
- an interdisciplinary approach is highly recommended to achieve the best possible results
- complex cases require a constant re-evaluation of patient compliance
Festival of complications

Dental implants are now being placed in a variety of different clinical circumstances, and by clinicians who are following many different protocols and using different ‘hardware’. This increase in the use of implants has, in turn, led to a rise in the occurrence of complications.

During this session, the speakers discussed factors that play a role in the incidence of complications and how to resolve them. The first speaker discussed complications specifically associated with fixed implant prostheses; the second focused on removable prostheses; the third shared tips and tricks for resolving and avoiding less ideal situations.

Treatment planning away from biological and technical complications

Ralf Kohal

Can we trust dental implants?

The speaker began with a surprising question: ‘Can we trust dental implants?’ He went on to say that several systematic reviews have concluded that the survival rate of implant prostheses is generally high. In cases involving single crowns, implant survival rate at five years is 97.2%, and at ten years is 95.2%. In cases involving fixed partial dentures, the figures are 95.6% and 93.1% respectively.

Based on this, he went to conclude that ‘Yes, we can trust dental implants’. Nevertheless, he emphasised that the risk of complications is always present, and the patient must understand that treatment does not end once the prosthesis has been installed (Figure 7.1.1). Factors which influence the incidence of complications are many and varied, and are therefore difficult to control.1

Crown/implant ratio

It is widely accepted that short implants with long crowns are not associated with marginal bone loss. There is general consensus, however, that this combination has the potential to lead to technical complications. We should carefully manage these cases in order to limit occlusal forces:

1 Jung et al. COIR 2012, and Pjetursson et al. COIR 2012, respectively

---

**SESSION 5**

**Treatment planning away from biological and technical complications**

<table>
<thead>
<tr>
<th>Author</th>
<th>Material</th>
<th>Survival</th>
<th>Observation period</th>
<th>Veneer Chipping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jung et al. (2012)</td>
<td>All-ceramic (Zr-based)</td>
<td>100%</td>
<td>6 months</td>
<td>7.5%</td>
</tr>
<tr>
<td>Pjetursson et al. (2012)</td>
<td>Metal ceramic / All-ceramic</td>
<td>98.7% mean: 5 years</td>
<td>8.2% (Cercon)</td>
<td></td>
</tr>
<tr>
<td>Kolgeci et al. (2014)</td>
<td>All-ceramic (Zr-based)</td>
<td>95.9% up to 7 years</td>
<td>23.1% (ZirPress)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>Metal ceramic</td>
<td>98.3% 2.1 years</td>
<td>24.5% (Cercon Kiss)</td>
<td></td>
</tr>
<tr>
<td>Pozzi et al. (2015)</td>
<td>All-ceramic (Zr-based)</td>
<td>97.2%</td>
<td>5 years</td>
<td>62% (NobelRondo)</td>
</tr>
</tbody>
</table>

**Summary results for veneer chipping for the different implant-supported reconstructions and materials**

<table>
<thead>
<tr>
<th>Author</th>
<th>Treatment</th>
<th>Material</th>
<th>Survival</th>
<th>Observation period</th>
<th>Veneer Chipping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jung et al. (2012)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>93.8% 5 years</td>
<td>62% (e.max ZirPr.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>SC All-ceramic (Zr-based)</td>
<td>97% 3 years</td>
<td>4% (Empress, eMAX)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>SC All-ceramic (Zr-based)</td>
<td>100% 4 years</td>
<td>85% (In-Ceram)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>SC All-ceramic (Zr-based)</td>
<td>97.5% up to 7 years</td>
<td>3% (In-Ceram)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>SC All-ceramic (Zr-based)</td>
<td>100% mean: 5.5 years</td>
<td>13% (NobelRondo)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

1 Jung et al. COIR 2012, and Pjetursson et al. COIR 2012, respectively

---

**SESSION 5**

**Festival of complications**

**SESSION 5**

**Treatment planning away from biological and technical complications**

<table>
<thead>
<tr>
<th>Author</th>
<th>Material</th>
<th>Survival</th>
<th>Observation period</th>
<th>Veneer Chipping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jung et al. (2012)</td>
<td>All-ceramic (Zr-based)</td>
<td>100%</td>
<td>1 year</td>
<td>18.2% (VITA VM9)</td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>SC All-ceramic (Zr-based)</td>
<td>98.7% mean: 5 years</td>
<td>8.2% (Cercon)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>SC Metal ceramic / All-ceramic</td>
<td>96.3%</td>
<td>8 years</td>
<td>40% (In-Ceram)</td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>93.8% 5 years</td>
<td>62% (NobelRondo)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>95.9% up to 7 years</td>
<td>23.1% (ZirPress)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>100% mean: 2.5 years</td>
<td>23.1% (ZirPress)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>93.8% 5 years</td>
<td>62% (NobelRondo)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>95.9% up to 7 years</td>
<td>23.1% (ZirPress)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>100% mean: 2.5 years</td>
<td>23.1% (ZirPress)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>93.8% 5 years</td>
<td>62% (NobelRondo)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>95.9% up to 7 years</td>
<td>23.1% (ZirPress)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>100% mean: 2.5 years</td>
<td>23.1% (ZirPress)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>93.8% 5 years</td>
<td>62% (NobelRondo)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>95.9% up to 7 years</td>
<td>23.1% (ZirPress)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>100% mean: 2.5 years</td>
<td>23.1% (ZirPress)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>93.8% 5 years</td>
<td>62% (NobelRondo)</td>
<td></td>
</tr>
<tr>
<td>Larsson &amp; Vult von Steyern (2016)</td>
<td>FDP All-ceramic (Zr-based)</td>
<td>95.9% up to 7 years</td>
<td>23.1% (ZirPress)</td>
<td></td>
</tr>
</tbody>
</table>
consider the option of splinting, which can prove beneficial when no conical connections are used
axial forces on functional cusps are preferred; avoid eccentric contacts if possible
bear in mind that not all implant designs are suitable for an unfavourable implant/crown ratio

Ceramics as restorative implant materials
It would appear that classical technical problems associated with metal-ceramic prostheses have not been overcome by ceramics. The speaker reviewed veneer chipping in cases involving different implant-supported reconstructions and materials, and found that results varied widely (Figures 7.1.2 and 7.1.3).

Screw retention versus cementation. Which has fewer complications?
A review of the literature yields controversial results. There is insufficient evidence to distinguish between screw retention and cementation, and the decision ultimately rests with the personal preference of each operator.
With regard to the matter of excess cement, individual abutments with visible clinical margins are highly recommended: the deeper the margin, the greater the amount of concealed cement.

Removable implant reconstructions: factors influencing incidence and type of complications
Hugo de Bruyn

Implant overdentures in the mandible
Due to improved patient satisfaction and quality of life, mandibular implant overdentures are preferred to conventional dentures, and are considered the ‘minimum standard’ treatment for edentulous patients. This was stated in 2002 at the McGill conference. Since then, many questions have been raised:

how many implants should be placed?
what type of connection should be used?
what is the potential for complications and repairs?
what are the costs and benefits?
how can patients be selected to ensure greater effectiveness?

Reviews illustrated a long-term survival rate exceeding 95%, with good clinical performance and patient satisfaction. Implant number, length and bone quality, as well as the age of the patient, was found to have no impact on implant survival. Ongoing bone loss was documented in only 2.5% of patients, and generally alongside external risk factors such as smoking, or the presence of dehiscence in the initial surgery. Additionally, a 10-year follow-up study revealed that peri-implant health remained stable, provided that a programme of regular maintenance was followed.

Maxillary overdentures
A survival rate of 75% for maxillary overdentures on two first-generation implants was reported after seven years by Bergendal & Enquist (1998). Survival rates increased dramatically when 4–6 implants splinted with a limited resilience bar were used. Furthermore, fewer complications were reported when this type of reconstruction was selected.

Although initial treatment costs are reduced when two maxillary implants rather than the standard number of four are used to support overdentures, this technique should be used with caution. A recent one-year study has recorded various biological and technical complications as a result of this ‘economic’ option. These complications bring with them additional costs, and therefore increase the overall cost of treatment. The speaker therefore advised the use of overdentures supported by two maxillary implants only in cases where a minimally invasive procedure is indicated. Anatomical constraints in the maxilla, such as the presence of the sinus, make it difficult to achieve the required parallelism of the implants and may lead to divergence between them. This situation is further complicated in cases

4 Thomason et al. J Dent 2012
5 Vercruysen et al. COIR 2010
6 Dierens et al. in preparation
7 Bergendal & Enquist. IJOMI 1998; Slot et al. JCP 2016
8 Zembic et al. COIR 2016
involving non-splinted implants, because large discrepancies in implant direction may cause further soft tissue problems and technical complications with the attachments. Enhancing parallelism of the attachment’s insertion direction may be beneficial by using angulated implants, for example. This is visible in Figure 7.2.1.

**Impact of complications on treatment cost**

Complications can influence the overall cost of treatment, so preventing them can improve cost-effectiveness. Long-term maintenance and the possibility of complications must both be taken into account, and discussed with the patient from the outset (Figure 7.2.2).

A study currently being carried out at Ghent University has found that over time the annual cost of addressing complications equates to 2.1% of the initial treatment cost, and ranges from 0–14%.

9 Dierens et al. Unpublished data, Ghent University

An overdenture retained on a single implant in the mandible may be a cost-effective alternative to one that uses two implants due to lower component costs and shorter treatment times. The evidence suggests that patient satisfaction and ease of maintenance are similar.

**Patient-centred outcomes: quality of life**

Successive investigations carried out at Ghent University have shown high levels of patient satisfaction with implant-supported prostheses. OHRQoL improvements were observed in all the following categories (see Figure 7.2.3):

- full fixed
- overdenture
- single tooth replacement

9 Dierens et al. Unpublished data, Ghent University


11 Ghent University PhD theses: Raes 2010, Browaeys 2013, Dierens 2014
How to solve – or better how to avoid – technical complications

Oliver Brix

The speaker presented several clinical cases in which poor placement of implants had led to soft tissue volume defects. He then outlined how these defects had been masked by appropriate use of pink porcelain.

He then went on to discuss issues relating to porcelain chipping. This can be caused both by the limitations of the material, and the patient’s functional habits. Monolithic zirconia prostheses are stronger and less prone to chipping, but are unable to meet aesthetic requirements in the anterior region. For that reason, the speaker posited that the best solution may be a combination of micro-veneered monolithic zirconia frameworks with lithium disilicate laminates.

He explained that he favours non-metal reconstructions because of their aesthetic results. For a single-tooth replacement, he proposed covering and cementing a titanium base with a customised zirconia abutment in the lab to be restored with a lithium disilicate cemented crown.

Re-firing porcelain always presents a challenge. A chemical system for cleaning and disinfecting the ceramic is strongly recommended to prevent it from shattering.
Bone biology: where do we stand?

This session was devoted to recent advances in bone biology and how they can be applied to osseointegration. The first presentation focused on implant concepts influenced by recent bone research; the second provided new insights into the bone-implant interface; the third painted a modern vision of osseointegration and discussed peri-implantitis.

Cell biology and immune response related to implant dentistry

Reinhard Gruber

Can inflammation support bone regeneration?\(^1\)

Inflammation is usually involved in tissue destruction, as, for example, in the case of periodontitis. Transient inflammation, however, is an essential step in the process of bone regeneration and fracture repair. The role and clinical significance of TNFα and COX-2 in bone healing is well established (Figure 8.1.1), and it is recognised that the suppression of early inflammation may in fact hinder bone regeneration.

The role of fibrinolysis

Fibrinolysis plays an important role in the healing process, as it enables newly-formed capillaries to penetrate the fibrin matrix. Fibrinogen is a key factor in the formation of fibrin; plasminogen is crucial for the process of fibrinolysis and plays a vital role in bone regeneration (Figure 8.1.2). Impaired fibrinolysis may have a negative impact on bone regeneration, so strategies for enhancing fibrinolysis should be investigated. This is especially important in cases which also involve obesity, smoking, diabetes or chronic inflammatory disease, where fibrinolysis is impaired\(^2\).

Are macrophages required for bone regeneration?

Macrophages are a key component of the mononuclear phagocyte system (Figure 8.1.3). They are found in all tissue-types throughout the body and are extremely versatile, displaying a variety of functional phenotypes depending on environmental signalling. Following tissue damage or infection, monocytes are attracted to the damaged site, where they differentiate into tissue macrophages as required; in bones, they become osteal macrophages, or ‘osteomacs’.

It has been demonstrated (experimentally) that macrophages control the wound healing process, and also play a key role in the reversal phase of bone remodelling, as well as in bone regeneration. It is now thought that biomaterials can support the differentiation of macrophages into their ‘regenerative’ phenotype.

Can blood vessels provide bone cells?

It is widely accepted that blood vessels provide the progenitors of both osteoblasts and osteoclasts. The progenitors of bone-forming osteoblasts are preferentially associated with a specialised population of endothelial cells providing signals that support bone formation and maturation (Figure 8.1.4). Thus, more bone walls in the osseous defect lead to higher levels of angiogenesis, the process by which new blood vessels are made. It is also necessary to provide mechanical stability in the wound in order to facilitate angiogenesis and consequently bone formation.

Insertion torque and osteocytes

Far from being the passive cells that we previously thought them to be, osteocytes play a significant role in orchestrating bone formation and bone resorption. They are crucial in the processes of mechanotransduction, mineralisation of the bone extracellular matrix and bone homeostasis, through the modulation of osteoblast and osteoclast activity. Apoptosis of osteocytes triggers osteoclastogenesis including osteocyte-derived RANKL (Figure 8.1.5). Thus, high implant insertion torques can cause increased compressive stress and micro-cracks in the bone, and may trigger osteocyte apoptosis. This can, in turn, result in increased bone resorption (Figure 8.1.6)\(^3\).

1 Further details of this report are summarised in the recent review by Gruber, Stadlinger, Terheyden: ‘Cell-to-cell communication in guided bone regeneration: molecular and cellular mechanisms’, COIR 2016
2 O’Keefe et al. New Eng J Med 2015
3 Cha et al. J Dent Res 2015
**Transient inflammation: bone regeneration**

- Zhang et al. COX-2 is critically involved in bone repair. JCI 2002
- Simon et al. COX-2 is essential for bone fracture healing. JBMR 2002
- Gerstenfeld et al. Impaired fracture healing in the absence of TNF-alpha. JBMR 2003

**Plasminogen is required for bone regeneration**

**Tissue-resident „osteal“ macrophages**

- Kawao et al. JBMR 2013
- Yuasa et al. JCI 2015

**Blood vessels: Origin of osteoblasts**

- Nuclei
  - Osteoblast progenitors
  - Epithelial cells

**Osteocyte apoptosis: bone resorption**

- PBS diphtheria toxin
- Wild type
- Diphtheria toxin receptor exclusively in osteocytes

**Insertion torque: possible bone damage**

Tailoring the surface of implants
The properties of implant surfaces can be modified in order to trigger biological responses. These responses are induced by a series of physicochemical characteristics encoded at macro-, micro-, and nano-levels. Oxidised surfaces, for example, can affect the initial inflammatory phase and promote osteogenic differentiation and osteoclast activity. When compared with machined surfaces, oxidised surfaces promote in vivo a higher degree of mineralised bone apposition on the surface. Apatite can also be detected in sub-micron pores, suggesting bone bonding.

Cells communicate at the implant surface via exosomes
The adhesion and osteogenic differentiation of mesenchymal stem cells on titanium surfaces is promoted by their co-culture with macrophages, perhaps by means of secreted exosomes. As well as providing soluble factors, exosomes constitute an additional mode of cell-to-cell signalling with an effect on stem cell differentiation during the transition from injury and inflammation to bone regeneration. Mesenchymal stem cells also release exosomes, which are internalised by other stem cells and trigger osteogenic differentiation and extracellular matrix (ECM) mineralisation. The regulatory effect on osteogenesis by exosomes is partially exerted by exosomal micro-RNA.

New role of the collagen membrane for GBR
The prevailing explanation for GBR points to the role it plays in providing a barrier against soft tissue invasion. It has recently been observed, however, that inflammatory and osteoprogenitor cells can migrate to the collagen membrane and release factors encouraging tissue/bone regeneration. This is suggested by the similarity between the gene expressions of bone markers in both the membrane and in the remodelling defect. These phenomena have important clinical implications, and could pave the way for innovative membrane-surface tailoring, which would improve the role of the membrane in bone regeneration by acting as a truly bioactive compartment.


What is osseointegration in 2016 and why are we losing bone around dental implants?

Tomas Albrektsson

‘Peri-implantitis’ – a foreign body reaction or a man-made ‘disease’?

Peri-implantitis is a controversial topic, with a discrepancy between the high reported rates in recent publications and the experience of clinicians. The definition of peri-implantitis as a common infectious disease similar to periodontitis is problematic in several ways.

Fundamental differences between the interface of teeth and implants with bone make them react differently. A study by Becker et al. on the transcriptomic profiling of both concludes that periodontitis and peri-implantitis exhibit different mRNA signatures:

> While in peri-implantitis tissue the regulation of transcripts related to innate immune responses and defence responses were dominating, in periodontitis tissues bacterial response systems prevailed.8

A recent clinical study of marginal bone loss in areas surrounding implants and teeth also seems to illustrate this, finding that bone loss in both areas behaved differently9. The authors conclude: ‘marginal bone loss at implants and teeth … might be independent phenomena’. It has been shown that periodontal markers such as bleeding on probing (BoP) and periodontal disease (PD) are not reliable tools for diagnosing implant disease10.

In contrast to periodontitis, the onset of marginal bone resorption around oral implants is unrelated to bacteria or plaque. Rather, it is an aseptic reaction which arises as a complication of treatment. Sometimes it progresses and becomes problematic, and sometimes it remains in equilibrium, dormant for decades (Figure 8.3.1).

There is also evidence that contradicts the allegedly high incidence of peri-implantitis. Jemt et al. documented marginal bone levels around implants in the cohort of 182 patients evaluated by Fransson and co-workers 9 years earlier11. They found that 91.4% of the allegedly affected implants had suffered no further significant bone loss than was initially reported, and that 95.3% still survived. The authors offered another intriguing conclusion: ‘Treated patients did not perform better than untreated patients with regard to bone loss or implant failure’. To better understand these issues, we must go back to osseointegration as it was originally conceptualised.

Osseointegration revisited

Body defence mechanisms can respond to the insertion of an implant in two ways: the implant fails and is expelled (primary failure), as happens in 1–2% of cases, or the implant is accepted and becomes encapsulated by a bone envelope. Secondary marginal bone loss depends on immunological phenomena, resulting in a delayed expulsion of the implant or late failure. This remodelling response may result in:

- minor bone resorption taking place over decades
- later complications, potentially resulting in infections
- aseptic loosening (Figure 8.3.2)

The balance of osteoblasts and osteoclasts is not only an expression of bone homeostasis, but the cells themselves are also part of the immune system12. Marginal bone loss may be the result of multiple factors that cumulatively activate the immune system (with complement, macrophages, B- and T-cells), tilting the delicate balance between osteoblasts and osteoclasts towards resorption (Figure 8.3.3). However, even if immunological reactions result in bone resorption, we cannot ignore the fact that bacteria may plan an additional role in this process.13

9 Cecchinato et al. COIR 2016
Substantial bone loss observed after the first year of implant placement.

Peri-implantitis? Actions?

RESPONSE PROPER:
Do nothing at all. This is Marginal Bone Loss but no disease. You cannot base a statement on disease on a single radiogram even if some milli-meters of bone has been lost.

This is a 50-year control of a perfectly functioning implant placed in 1964. Courtesy of Dr Luca Pagliani

Figure 8.3.1

Bone loss with infection may follow first many years later in a few cases – most implants will see natural cessation of aseptic loosening without further problems

Dangerous bone loss

With time the delicate balance between the osteoblast and the osteoclast is influenced; osteoclasts dominate and bone resorption follows (Albrektsson, Canullo, Cochran & De Bruyn 2016).

Fortunately, provided the use of clinically documented implants placed by trained individuals problems with implant threatening bone resorption is limited to 1-2% of placed devices over follow up times of 10 years or more

Figure 8.3.2

Figure 8.3.3
Tips and tricks for a successful implant practice

In this session, three factors which can contribute to a successful practice were discussed together for the first time:

- the rapid evolution of knowledge and new techniques means dentists need to be well-trained and stay up to date. The first presentation described the EAO’s new Education Programme which aims to help clinicians meet the current demands of implant dentistry
- the second presentation explored the growing need for photographic documentation in practice, and how to use dental photography to document and communicate treatment
- the final presentation looked at practice management and provided insights and tips on developing a successful strategy for this

Introduction to the EAO Education Programme

Helena Francisco

The EAO and education

The EAO’s vision is ‘to improve the quality of patient care by bridging the gap between science and clinical practice’1. One of the ways it works towards this aim is through educational initiatives.

In 2010, the EAO launched its Certificate in Implant-based Therapy to establish an appropriate international standard of competency, and to support high-quality practice via accreditation. From 2015 onwards, the EAO has also been organising Master Clinician Courses which focus on a variety of subjects in implant therapy to improve the expertise of participants.

Now, the EAO has taken a further step, introducing a comprehensive Education Programme which enables candidates to undertake structured learning over a three-year period covering cases at all levels of complexity. The programme combines theoretical knowledge with hands-on courses at some of Europe’s most prestigious universities. Successful candidates receive the EAO’s Postgraduate Diploma in Implant-based Therapy. The programme provides an additional pathway to attaining the EAO’s Certificate in Implant-based Therapy.

The Education Programme

The complete curriculum comprises 250 hours of theoretical and practical training which takes place over a period of three years. The programme is split into six modules: two per year hosted by different European universities. The breadth of the programme is extensive and covers subjects including surgery; prosthodontics; periodontics; and treatment planning or maintenance in every module.

The level of complexity of the modules is based on the SAC Classification, with two modules at straightforward (S) level; two advanced (A) modules; and two complex (C) modules. This provides an increasing degree of complexity as the programme progresses.

How does it progress

Each module begins with preparation through the EAO’s bespoke online learning platform. This is followed by a three-day live learning event (LLE) which combines hands-on elements, lectures, small-group seminars, practical sessions and live surgery. Online mentoring is also provided between

---

1 www.eao.org
modules, and each participant is paired with one or more expert clinicians on a one-to-one or small-group basis. Each group of participants receives approximately eight hours of mentoring. Mentoring sessions are structured around clinical cases that the student is expected to perform and document between each module.

Admission is open to applicants with a dental degree who have been practising for at least two years. All six modules must be undertaken to complete the programme, at which point successful participants receive the EAO Postgraduate Diploma in Implant-based Therapy.

<table>
<thead>
<tr>
<th>Module 1 &amp; 2</th>
<th>Straightforward (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basics/ Theory</td>
<td>Planning / Seminar</td>
</tr>
<tr>
<td>History</td>
<td>Bone Physiologgy</td>
</tr>
<tr>
<td>Sem 1</td>
<td>Posterior single unit; short &amp; extended edentulous space; Low esthetic risk; sufficient bone volume</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module 3 &amp; 4</th>
<th>Advanced (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basics/ Theory</td>
<td>Planning / Seminar</td>
</tr>
<tr>
<td>Defect classifications</td>
<td>Bone morphometry</td>
</tr>
<tr>
<td>Sem 3</td>
<td>Posterior single unit; short &amp; extended edentulous space; full edentulism; Low esthetic risk; horizontal deficiencies; simultaneous grafting (GBR)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module 5 &amp; 6</th>
<th>Complex (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basics/ Theory</td>
<td>Planning / Seminar</td>
</tr>
<tr>
<td>Anatomical changes due to atrophy in maxilla and mandible</td>
<td>Harvesting areas for bone grafts</td>
</tr>
<tr>
<td>Sem 4</td>
<td>Esthetic Zone single unit; short &amp; extended edentulous space; horizontal deficiencies; simultaneous grafting (GBR). Immediate placement with low esthetic risk</td>
</tr>
</tbody>
</table>

| Figure 9.1.1 |

| Figure 9.1.2 |

| Figure 9.1.3 |

Congress Scientific Report, Issue 2, February 2017
How photography can improve your private practice

Antonello Appiani

The main goal of taking dental photographs is to document the different stages of treatment.

How to take photographs that are suitable for documentation

Equipment and settings for inexperienced users:
- use a digital SLR camera (D-SLR)
- work in ‘aperture priority’ mode
- set the aperture value to F32 or higher
- enable auto ISO
- use a ring flash in auto flash mode
- set white balance to 5,500K or flash mode
- use an exposure speed of 1/60s
- use manual focus for intraoral images and autofocus for full-face pictures

Advanced equipment for experienced users:
- D-SLR Prosumer or Pro (D7100 or D610)
- 50mm and 105mm macro lenses
- twin flash and flash bracket

Advanced settings:
- use manual mode
- aperture value of F32 or more
- ISO 200
- flash manual mode with 1/1 of power
- exposure time 1/125s
- a ring flash is easy to use, but can make the image lose its 3D quality. Twin flash is more expensive and heavier, but is also more creative and allows you to position the flashes parallel to the lens

Other elements to bear in mind when taking dental photographs:
- the use of black backgrounds is always highly recommended, especially in anterior areas, as the contrast highlights tooth translucency
- higher quality mirrors allow for higher levels of reflection
- polarising filters help minimise reflections

Why should we document treatment?

1. Diagnosis and treatment planning
   Photographs can help clinicians develop treatment plans. They can be analysed after the patient has gone and images can be enlarged to reveal fine detail. In orthodontic and prosthetic situations, for treatment in the aesthetic zone, photographs allow you to analyse facial and oral frames by tracing reference lines and planes. This helps formulate the best treatment plan. However, the photographs must be taken with perfect symmetry and without positioning errors or perspective distortion in order for them to be usable.

2. Increased patient education and communication
   Using smile design software in conjunction with photographs can help the patient visualise treatment outcomes and make it easier for the practitioner to understand their treatment goals. Compared with traditional wax-ups, the possibilities provided by photography software are huge. Photographs of the try-in or mock-up can clarify the patient’s perception of the treatment plan, helping them express their wishes and make the best informed decision.

3. Communication with the laboratory
   Treatment plans can also be shared with the laboratory technician who will use the additional information as a visual interpretation of the clinician’s ‘prescription’. This reduces the likelihood of confusion or miscommunication. ‘One picture is worth a thousand words.’ (Figures 9.2.1 and 9.2.2)

4. Legal documentation
   Photographs can also help resolve disagreements between dentists and patients before a potential dispute reaches the litigation stage. We cannot rely on our memories alone to resolve patient complaints. Photographs can provide proof of the condition of the mouth before and after treatment, and are valid for use as forensic records. This provides legal protection for both the dentist and the patient.

5. Improving our practice
   Photographs are also essential tools for case presentations, or as part of sharing and training programmes. During follow-up examinations, dental photography is very useful for studying the evolution of the case and evaluating treatment outcomes. It is a useful tool for providing feedback to learn from our own practice.

Dental photography can be used as a kind of ‘quality control’ measure. By enlarging and projecting photographs, any weaknesses in a treatment plan will also be magnified, making them easier to identify. This helps us prevent potential mistakes and improve our future practice.

Figure 9.2.1

Figure 9.2.2
Private practice management and development

Sarah Chick-Richardson

Each patient who comes to our office presents a different case, and each case has its own challenges and scope for successful resolution. To know how to approach them, it is crucial to have detailed and personalised information. This is both a science and an art: the science is to provide patients with evidence-based treatments to the best of our ability; the art is to correctly apply appropriate protocols to individual patients. To this end we must employ a variety of skills: communication; patient advice; marketing; and so-called business intelligence.

Communication
There are three main questions we must ask:

- who is responsible for communication?
- what needs to be communicated?
- what is good communication and what is bad?

Almost everyone working in the clinic has the opportunity to communicate, whether they are dentists, auxiliaries, reception staff or members of the management team. The type of information that needs to be communicated depends on the situation. To achieve good communication the following should be observed:

- the flow of information must be managed appropriately
- channels of transmission should be taken into account
- the vocabulary should be selected accordingly, along with an awareness of who is delivering the information
- care must be taken to ensure that non-verbal communication is of a high standard too

‘People management’
Recognising individual needs is the starting point when advising patients. We must be aware of our own training and limitations, and should be eager to meet the patient’s needs and keen to solve any problems. Finally we should be objective in our treatment planning, in deciding what the patient needs, and in estimating the value of the treatment.

Marketing
The success of a private practice depends on having a sound business plan and a marketing strategy that will promote its strengths.

When designing a treatment plan and its corresponding budget, we often have to balance patient expectations against what is available using evidence-based treatment. Information gathered by the patient prior to treatment is extremely important, and their expectations must therefore be tempered. On the other hand, when we ask patients what they want, it often comes down to a few simple things. Our proposals should be kept uncomplicated and be delivered in a clear and concise manner.

Word of mouth is the most powerful tool for promoting your practice, and it is how you can build a network of referrals. This can only be achieved by satisfied patients, and this is above all what we should strive for.

Business intelligence
Business intelligence, and being smart about how you manage your practice, will help you build a strong development strategy. To start, a few vital questions must be answered:

- where has each patient come from, and what was the source of the referral?
- how many new patients do you have and do you need?
- how many clinical hours do you and your team have available each year?
- how do you maximise the value of this time?

Depending on your answers to each question, a development strategy can be built that is tailored to the individual needs and characteristics of your clinic.

The patient journey
To succeed in business, you must understand each type of patient and treat them accordingly. For returning patients, it is important to know what made them come back to the clinic and trust you again; their new needs must then be assessed. For new patients, you should find out what brought them to the clinic (for instance an advert; a publicity campaign; or word of mouth). This information should be recorded and can be used later to further enrich that source of new patients.
How to avoid the carpenter’s approach to implants

A number of clinical reports have been published on immediate loading since the 1990s. Over the last two decades, positive outcomes for immediate implant restorations – removable or fixed – have been supported by a large body of evidence in virtually all clinical situations. This has led to a trend towards increasing primary mechanical stability above the previously recommended levels. As a result, clinicians now generally prefer a higher insertion torque, without taking into account its biological impact on living bone.

The influence of insertion torque on primary stability, implant survival and marginal bone loss

Michael Norton

Primary stability is the big issue
In early and immediate provisionalisation/loading, primary implant stability is one of the most important factors for ensuring safety and predictability. But how much primary stability is needed?

Primary stability results from a mechanical connection between an implant and the surrounding bone. The way in which the implant and bone interlock with each other reduces micromotion and shear forces at the interface while transferring forces to the bone. This mechanical stiffness is typically measured as rotational friction and registered as insertion torque.

Factors that can influence primary stability are:
- implant design (geometry; thread profile; interfacial design; surface preparation)
- bone density (especially cortical thickness)
- surgical protocol (osteotomy preparation)

There are several methods for evaluating primary stability:
- tactile perception, although results are subjective and difficult to quantify, due to variation between operators
- Periotest, involving an evaluation of micromotion; it is similarly unreliable

Two methods which are increasingly being used are:
- peak insertion torque (PIT)
- resonance frequency analysis (RFA)

Are PIT and RFA different?
Both methods assess different aspects of stability, and could even be said to complement one another. While PIT measures the resistance of shear forces or rotational stability registered in Ncm, RFA measures the axial stiffness of the implant – the resistance to lateral micromovement – and is registered as an implant stability quotient (ISQ) (Figure 10.1.1).

This may be why most studies have discovered little or no correlation between PIT and ISQ values. Furthermore, it has been shown that PIT is unreliable for predicting implant failure. By contrast, ISQ has been seen to predict implant success: higher ISQ values at implant placement have been observed in successful implants. In a cadaver study, a significant correlation between insertion torque and bone density has been found, but no correlation between insertion torque and ISQ.

How much insertion torque is needed?
The speaker has published a study on immediately placed and restored single-tooth implants. In it, he concludes that an insertion torque of 10–25Ncm – lower than is generally recommended – can yield favourable survival rates, while optimising the maintenance of marginal bone levels (Figure 10.1.2). In a clinical study on immediate rehabilitation of the edentulous maxilla, the overall cumulative implant

2 Al-Nawas et al. IJOMI 2006
3 Boustany et al. IJOMI 2015
4 Norton MR. IJOMI 2011
survival rate was 96%, even though 38% of the implants had an insertion torque of 10–20Ncm\(^{3}\).

A recent clinical study involved 59 immediately placed implants with an ISQ ≤ 69 and different insertion torques (20–50Ncm). 100% of the implants achieved a good outcome, illustrating that a low insertion torque may not be a factor for predictable success in immediately placed implants\(^6\). Although there is still no consensus regarding the optimal insertion torque value for loading implants, this value is now trending downwards.

Implant design must also be taken into account, as primary stability is partially system-dependent. Additionally, the maintenance of implant stability during the post-surgical healing period is of the utmost importance to allow primary stability to become secondary stability.

By contrast, some authors argue that high insertion torques can damage interfacial bone and produce micro-cracks, due to increased bone strain and excessive bone compression. Micro-cracks can trigger further bone remodelling, and may delay osseointegration or result in increased marginal bone loss\(^7\). This hypothesis has not been confirmed by other studies\(^8\).

From insertion torque to ‘viable constraint’ (vC)

‘Viable constraint’ is a concept which combines both values of stability (PIT and ISQ) and considers the critical pressure on bone. It may prove preferable to insertion torque. Several clinical studies have demonstrated that 25Ncm is sufficient for immediate loading protocols. It is therefore recommended that viable constraint is set at PIT = 20–25Ncm and ISQ = 60. If one value falls below these thresholds, it can be counter-balanced by the other. For example, an implant with a PIT = 15Ncm and ISQ >65 may still be safe for immediate loading (Figure 10.1.3).

8 Li et al. IJOMI 2015; De Sanctis et al. IJOMI 2016

How should implant stability be assessed?

RFA measures resistance to lateral micro-movement
Torque measures resistance to shear forces
Micro-movement could jeopardize the treatment outcome

The Influence of Insertion Torque on Implant Survival in Immediately Placed and Restored Single-tooth Implants

It can be concluded that immediate temporization of single-tooth implants placed with a low insertion torque (10–25Ncm) can yield favorable survival rates with optimized maintenance of marginal bone levels compared to the generally accepted norm.
Evidence-based implant carpentry. What are you using, what are we doing?

Ryo Jimbo

When using the analogy of carpentry, we must distinguish the good carpenter from the bad. As Norton explained in a recent IJOMI editorial, primary stability is not the same as insertion torque. Further, mechanical stability is not the only aspect that must be considered (Figure 10.2.1). It is important to support the shift from primary stability (highly dependent on macro-geometry and instrumentation), to secondary stability (achieved by the deposition of new bone on the implant surface). The bad carpenter’s approach compromises this biological process, and must be avoided.

Primary stability depends on three factors:

- **Bone quality and anatomical morphology:** both are relevant in determining insertion torque values.
- **Macro-design:** insertion torque is specific to implant design (Figure 10.2.2); there are differences in short-pitch and healing chamber macro-design types, the latter show lower torque but good stability.
- **Surgical approach:** the drilling protocol should be adapted to the bone composition.

In conclusion, a good clinician must understand and measure primary stability, managing the tools available in order to achieve it, and combining clinical experience with evidence (Figure 10.2.3). A good clinician is a good carpenter and a good scientist.

9 Norton MR. IJOMI 2013, editorial

10 Lindhe et al. COIR 2012; Stanford et al. IJOMI 2016
Bone versus implants! Do we need to grant the biomechanical to the biological? The orthopaedist’s perspective

Thierry Joudet

The answer is yes!
Bone is an important organ and performs essential physiological functions, providing:

- mechanical support
- mineral homeostasis (phosphocalcic metabolism)
- a location for haematopoiesis
- endocrine function

Bone has an anisotropic morphology with two basic types:

1. Cortical bone, which is compact and characteristically stiff, with a Haversian structure and porosity less than 30%
2. Cancellous (also known as trabecular or ‘spongy’) bone, with a porosity ranging from 30 to 90% and a higher vitality and biological reactivity

Factors relating to bone formation and repair include:

- it takes place in four locations (medullary canal, cortex, periosteum, soft tissue)
- it involves two kinds of consolidation (primary bone healing, which involves direct Haversian remodelling by the cortex itself; and secondary repair involving responses in the periosteum and external soft tissues)
- it features two types of ossification (intramembranous and endochondral)
- it is characterised by five stages (haematoma, inflammation, angiogenesis, cartilage formation and calcification, remodelling)

Bone is capable of self-repair (in cases of fractures, micro-fractures, and micro-cracks) via processes of modelling and remodelling. These processes are based on basic multicellular units (BMUs), which respond directionally to mechanical loads. Stem cells are precursors to osteoblasts. They are attracted to the site of bone formation and differentiate into osteoblasts according to signals released by osteoclasts. This makes up a system of feedback between the two cells (Figure 10.3.1).

Osseointegration at implant surfaces is governed by cytokines. It takes time – about three months – for the process to achieve mechanical stability through maturation and mineralisation to become lamellar bone. After surgical trauma, bone tissue must remodel itself in close contact with the implant walls. This involves a delicate balance between surgical technique, biological environment and implant design, which must be achieved to ensure success. Excessive inflammation, cytotoxicity and activation of the complement system are potential dangers. If the balance tilts towards biocompatibility, the process can be regarded as bio-tolerance, bio-inertia or bio-activity. This, in turn, stimulates in consecutive order osteoconduction, osteoinduction and finally osteogenesis. Implant surfaces must be engineered with sufficient porosity at macro, micro and nano levels. In the future, surfaces may be biologically configured by stem cells or BMPs (bone morphogenetic proteins) (Figure 10.3.2).

The speaker finished his presentation with a review of the evolution of orthopaedic implants from 1893 to the present day, through the astonishing history of the Joudet family. Different biomechanical designs have been developed for over a century to deal with stress shielding, wear and unsealing of prostheses. The most recent designs are smaller, allowing for less invasive surgical installation. They feature surface treatments that are designed to stimulate inductive support for the desired biological outcome (Figure 10.3.3).
Emerging technologies: head-to-head

New materials and technologies are constantly being developed, but it takes time to build a body of clinical evidence following preclinical and experimental evaluations. Until this emerges, clinicians are in a no man’s land where opinions and experiences are exchanged, and opposing viewpoints are discussed. In this session three different and currently hotly debated procedures and technologies were discussed.

Hand guided surgery versus guided surgery
Daniel Wismeijer

Where we are currently: trying to get the prosthesis to fit
Digital workflows are still imprecise and less accurate than we would like them to be. Deviations between the planned implant position and the final position that is achieved by guided surgery are inevitable.

A recent systematic review and meta-analysis has assessed the deviations recorded in 24 studies involving computer-assisted surgery. The results showed the following deviations:

- mean 1.12mm (maximum 4.5 mm) at the entry point
- 1.39mm (maximum 7.1mm) at the apical location
- 3.9° mean axial deviation (maximum 21.2°)

Complications were reported in 36.4% of cases, including:

- template fractures during surgery
- unexpected changes in the surgical plan
- insufficient primary implant stability achieved
- additional grafting required
- problems relating to poorly fitting prostheses (screw loosening or prosthesis fracture)

The study reported no differences that were statistically significant between:

- the maxilla vs. the mandible
- fully edentulous vs. partially edentulous patients
- the study design (cadaver, model or clinical)
- guide production method

Significantly larger deviations were revealed in the P-values documented in tooth-supported guides vs. bone-supported guides. The latter were associated with greater deviations. Further, it seems that flapless approaches proved more accurate, but this may be due to the use of bone-supported guides when a flap was raised. Finally, fully guided implant insertion was found to be more precise than free-hand insertion.

Instrument inaccuracy (Figure 11.1.1)
CBCT scanning has its own inherent inaccuracies. Multiple factors may influence deviations even within the same device, such as field of view (FoV) selection; voxel size; radiation parameters; patient anatomy and positioning; patient movement during exposure; and segmentation threshold for reconstruction.

On the other hand, there can also be dimensional errors in the data obtained from intraoral scanners. As the distance between bodies being scanned increases, the precision of intraoral scanners decreases, unlike with lab scanners. Thus deviations have been found when surface scan models and the same models derived from CBCT data are

---

1 Throughout this presentation, guided surgery refers to static guided surgery, not dynamic navigation
2 Jung et al. IJOMI 2009; Tahmaseb et al. IJOMI 2014
3 Hasan et al. Clin Oral Investig 2010
superimposed’ (Figure 11.1.3). The fabrication of drilling templates and drill tolerances are additional factors that may cause deviations.

**In this situation, could there be advantages to using hand-guided surgery?**

Foregoing surgical guides has its obvious advantages, especially when compared with errors that can arise when using ‘hand-brain’ surgical guidance. Some errors may present as postoperative complications, or later during the restorative phase. Most can be prevented by careful planning.


There is a need for an evidence-based evaluation of clinical indications to balance treatment accuracy against associated risks and help us decide whether the additional cost and effort of computer-assisted surgery is worth it.

Software is ubiquitous in all areas of technology, but can also be a ‘weapon of mass deceit’ because it discourages clinicians from doing the thinking for themselves (Figure 11.1.5). Currently, there is still insufficient evidence to demonstrate that computer-assisted surgery is systematically superior to conventional procedures in terms of safety, outcome, morbidity, or efficiency.

---

**Figure 11.1.1**

**Figure 11.1.2**

**Figure 11.1.3**

**Figure 11.1.4**

**Figure 11.1.5**
Autogenous bone blocks versus allogeneic bone blocks

Zvi Artzi

Autogenous bone blocks are still considered to be the gold standard. Augmentation using autogenous bone blocks increases 3D volume by up to 4.3mm horizontally and 4.7mm vertically. This is an improvement of about 30% compared with GBR procedures. The advantages of using autogenous bone blocks are:

- perfect biocompatibility
- no antigenicity
- bone inductive properties

A recent study involving autogenous bone blocks measured mean bone-implant contact at 42.34%, and new bone formation at 68.32%. Although it is still the subject of debate, a healing period is recommended before placing implants. Both experimental and human histological studies have reported that increased bone-implant contact can be obtained using a staged approach. Studies have also documented higher stability measured by ISQ and lower marginal bone loss.

It has yet to be assessed what percentage of the block remains vital and for how long while revascularisation takes place. During this process, a substantial amount of resorption has been recorded (up to 60%), and there is currently no way of preventing this. To compensate for these levels of resorption, the use of resorbable collagen membranes and anorganic bovine bone has been proposed. Another solution may be the use of bone decortication to enhance angiogenesis from bone marrow, but this has not yet been conclusively proven.

The most common complications that can arise include mucosal dehiscence, along with bone graft or membrane exposure, and complete failure of bone block grafts and neurosensory alterations. Exposures occurred more frequently in vertical than in horizontal augmentations. A recent systematic review reported complete graft failure in 8–20% of the cases.

With regard to donor site morbidity, altered sensation was measured in 62% of cases following surgery, when the block was removed from the symphysis. Thus patient morbidity; the frequency of postoperative complications; and the technical skill required for the procedure are all important concerns.

Can allogeneic blocks serve as an appropriate alternative treatment?
The view that allogeneic bone blocks can enhance ridge volume in a similar way to autogenous blocks, and without the associated mass reduction, is gaining momentum. Indeed, allogeneic bone blocks present some obvious advantages:


Figure 11.2.1

Figure 11.2.2
- the surgical procedure is shorter and simpler
- there is less morbidity
- there are fewer associated postoperative complications
- treatment acceptance is generally better among patients and surgeons

Allogeneic blocks come in several forms, each with their own characteristics. Cortical plates have a slow remodelling rate, whereas cancellous blocks exhibit less structural strength and have a higher rate of revascularisation. Cortico-cancellous blocks offer a mixture of both characteristics, with the thin outer cortical portion maintaining initial stability, and the inner cancellous part providing increased osteoconduction. There is no solid evidence, however, to prove that true osseointegration occurs between allograft blocks and implants.

Following an overview of the current literature, it can be concluded that there is insufficient scientific evidence to support the use of allograft blocks in generalised clinical situations. The systematic reviews mainly identified observational studies, most of which report good graft incorporation and implant survival in the short-term. By contrast, a recent study found that wound dehiscence occurred in 77.8% of cases. Another study in 2016 had to be cancelled due to the high rate of complications.

It has been documented – although with some variability – that only 8.4% of cases resulted in the formation of new bone, and about 50% in the formation necrotic bone. Some studies have reported poor graft incorporation and marked resorption over time, along with a higher incidence of graft exposure, and partial or total loss of the graft in some cases (Figures 11.2.1 and 11.2.2).

The speaker concluded with a table illustrating the outcomes associated with the various types of bone blocks (Figure 11.2.4).

13 Spin-Neto et al. COIR 2014, 2015; Chiapasco et al. IJOMI 2015
Connective tissue graft versus soft tissue substitute around implants

Giovanni Zucchelli

Recession of the buccal soft tissue margin around dental implants is a common complication which leads to elongation of the clinical crown, or metallic components becoming visible in the aesthetic zone. In the majority of cases, this is caused by poor positioning of the implant, resulting from the implant platform having been placed too buccally and/or apically.

It has been demonstrated that soft tissue plastic surgery procedures can be successfully used to correct soft tissue recession in conjunction with pre- and post-surgical prosthetic approaches. This treatment aims to relocate the soft tissue margin and takes approximately one year:

- there is an initial 2-month phase of soft tissue maturation and creeping. The implant-supported crown is removed and replaced with a shorter one. There should be no contact with the soft tissue, and the abutment diameter should be reduced by as much as possible
- once the soft tissue has grown to form papillae, the surgery can be performed using a coronally advanced flap combined with a connective tissue graft (CTG) deriving from the de-epithelialisation of a free gingival graft
- after the tissue has healed there is a second maturation phase of 4 months followed by a second conditioning phase. A new screw-retained provisional is fitted to put apical pressure on the zenith area and allow the papillae to fill the proximal spaces
- finally, the definitive abutment and restoration can be placed (Figures 11.3.1–11.3.3)

Can similar outcomes be achieved with soft tissue substitutes?

The speaker described how he had recently reviewed various surgical procedures whose goal was to increase keratinised tissue width, comparing apically positioned flap procedures with vestibuloplasty. He also compared different methods for autogenous soft tissue grafting (free gingival graft or connective tissue graft) versus methods that used biomaterials (acellular dermal matrices and collagen matrices). He found six clinical studies, three of which were RCTs. Soft tissue substitutes failed to produce better results in any of the studies, but favourable results were achieved using autogenous soft tissue in two studies. The other four reported similar outcomes. He concluded that free gingival grafts remain the gold standard, while collagen matrices reduce postoperative morbidity and surgical times, as well as achieving a better aesthetic outcome.

Conclusions

A peri-implant soft tissue margin about 2mm thick is required to ensure long-term stability. Currently, augmenting the thickness of the buccal soft tissue using CTG combined with a coronally advanced flap is a reliable procedure. It is crucial that sufficient papillae are available to de-epithelise, and that the flap is sutured coronally in order to achieve a good result. No risk of subsequent shrinkage has been observed, but rather a tendency for creeping. Although there is evidence to suggest that biomaterials are becoming a more reliable option than they were previously, it is advisable to use them in more straightforward cases, such as mucogingival surgery with teeth, but not in cases involving implants.

14 Zucchelli et al. COIR 2013; Roccuzzo et al. COIR 2014; Le B et al. JOMSurg 2016; Zucchelli et al. submitted

![Figure 11.3.1](image1.png)

![Figure 11.3.2](image2.png)

![Figure 11.3.3](image3.png)
Optimal long-term results for osseointegrated implants

Japan, as the invited country at the 2016 congress, presented a session delving into two interesting fields: bone augmentation and mechanobiology.

A new strategy for bone augmentation
Shohei Kasugai

The current status quo
Having enough bone around an implant is a prerequisite for long-term success. However, bone volume is often insufficient, making augmentation procedures necessary. Autologous bone grafts are still considered the gold standard, but the procedure is limited by the amount of harvestable bone available and associated with high patient morbidity. On the other hand, bone substitutes are less effective since they are only scaffolds and lack cells and signal molecules.

Tissue engineering
The current strategy for resolving this challenge is tissue engineering. This involves three key players: stem cells, signal molecules and an appropriate scaffold. These biological materials are combined exogenously in order to create functional tissue to facilitate regeneration.

Different types of stem cells have regenerative potential:
- embryonic
- induced pluripotent
- stimulus-triggered acquisition of pluripotency cells (STAP)
- mesenchymal

These cells work in conjunction with signal molecules – BMPs, PDGFs, FGFs, TGFs, VEGFs – and create new tissue within a scaffold structure which can be made out of collagen; fibrin; bone substitutes; or biodegradable polymers. The aim of tissue engineering is to apply these combinations in situ and biologically stimulate bone regeneration, achieving similar results to autogenous grafts.

Recent experiments involving signal molecules – such as PDGF and BMP-2 – or stem cells have found that they can be effective for bone augmentation. However, this procedure is not currently available in daily practice due to its complexity and cost.

A new membrane in development
A new synthetic GBR membrane is under development, made of a cholesterol-bearing pullulan (CHP) polysaccharide-nanogel. The membrane is cross-linked, and is capable of trapping both hydrophobic and hydrophilic molecules inside itself. Since CHP-nanogel is composed mostly of water (over 90%), the membrane can absorb endogenous growth factors secreted by tissues, exchanging them for water, and later release them to enhance bone regeneration. A study has demonstrated that the new CHP-nanogel membrane could store PDGF signalling molecules, and achieved better outcomes than traditional collagen membranes1.

In addition to growth factors, the new membrane can also incorporate small, biologically active molecules. For example, another study has shown that a CHP-nanogel membrane treated with prostaglandin E1improved the wound healing process2.

Is regeneration possible without graft materials?
A widely reported study has shown that space maintenance alone is enough for effective bone augmentation. The study also showed that scaffolds using xenograft materials alone were more effective than autologous bone3.

Furthermore, in some cases sinus membrane elevation can be achieved without the use of graft material. Another clinical study has concluded

3 Aghaloo & Moy IJOMI 2007
that graftless sinus augmentation can be a reliable technique, provided that space for bone formation is maintained\(^4\). The space created below the Schneiderian membrane provides a favourable four-wall defect.

**The expandable E-GBR concept**

In animal experiments, it has been discovered that periosteal elevation can encourage bone growth from the basal bone. This phenomenon is based on the same mechanism as Ilizarov’s principle of osseous distraction. Lifting the periosteum to stimulate bone formation under the barrier may open up new channels of vertical bone augmentation. Preliminary results from the experiment report an increase of about one third of a millimetre per day following elevation of the periosteum\(^5\).

This new direction in regenerative treatment is mainly based on the healing potential of bone. Instead of applying exogenous factors, which is the focus of the majority of current tissue engineering strategies, in this method bone is augmented solely by providing space.

---

**An analysis of dental implant treatment based on biomechanics and mechanobiology**

**Keiichi Sasaki**

**Why should we focus on force?**

Biomechanics concerns the effect mechanical forces have on biological tissues (Figure 12.2.1). Mechanical forces can cause stress in peri-implant tissues, with the amount of stress determined by bone morphology and density, as well as by loading technique. Excessive stress can produce tissue reactions including: inflammation; bone resorption; tissue and implant deformation; and bone remodelling.

One of the principles of mechanobiology is that these reactions stem from cellular processes such as differentiation; proliferation; and apoptosis, and are regulated by signals to cells which are generated by mechanical loading. Together they make up an active and adaptive response to environmental biophysical stimuli.

Although evidence is scarce, it is widely believed that high levels of mechanical stress – and the micro-cracks and micro-damage that can be caused by them – hinder bone homeostasis. This can lead to inflammation and bone resorption around the implants.

**Evaluating force on implants**

Few studies have been carried out to measure *in vivo* forces received by implants. Those that have been conducted generally used strain gauges, devices which are unsuitable for capturing the complex vectors associated with 3D forces. It is important to measure forces transmitted in 3D since the finite element analysis (FEA) software used to simulate force and its impact requires data that is as comprehensive and accurate as possible.

The authors of one study used a 3D piezoelectric force sensor to measure the magnitude and direction of functional forces of a tooth *in vivo*. It was then possible to measure the 3D force on the implant and include it among the data uploaded to the patient’s FEA. This meant that the stress distribution around peri-implant tissues could be truly evaluated. It was concluded that:

- lower stress levels were reported in the peri-implant bone of the splinted model than in the non-splinted model
- the model with four implants had favourable stress distribution and lower intensity than the system supported by two implants
- high stress levels were found around tilted distal implants and where thin cortical bone was present
- the results favoured the mechanical stability achieved by using more implants, and reinforced the benefits of using biological data-based FEA (Figure 12.2.2)

In a cantilevered fixed partial denture, the extended finite element method (XFEM) showed high stress and strain concentration around the implant near the cantilever side, which could increase the risk of mechanical failure\(^6\) (Figure 12.2.3).

**Mechanobiological reactions**

Moderate mechanical stress is required to maintain metabolic balance in osteogenic-dominant bone remodelling. However, the precise mechanotransduction mechanism that triggers the anabolic reaction of osteoblasts has not been defined in experiments. Consequently, the molecular differences between moderate and excessive mechanical stress are largely unknown.

Using a cell stretch system (ST-140 Strex), the sequence of signalling molecules elicited by mechanical stimuli on the cultured osteoblasts could be observed. It was found that lower levels of stress contributed to osteoblast differentiation, whereas higher levels caused cell apoptosis. Using RNA interference screening, it was possible to determine which intracellular signalling pathways were activated during osteogenesis, and which

---


\(^5\) Zakaria et al. J Tissue Eng 2012

\(^6\) Kawaguchi et al. J Biomech 2007


played a role in protecting against mechanical stretch-induced apoptosis.9

The relationship between bone metabolism and loading

The speaker offered some insights into bone metabolism dynamics using bone scintigraphy with radionuclides and positron emission tomography-computed tomography (PET-CT) scanning.

An experimental study using bone scintigraphy has documented the changes that occur in bone metabolism around implants under mechanical stress. Two implants were inserted in medial proximal tibiae of rats, and load was applied using closed-coil springs with 0.5 to 4.0Ncm. It was concluded that bone metabolism around the implants increased with loading, depending on magnitude and duration10.

10 Sasaki et al. IJOMI 2008

Using the same animal model, and also using bone scintigraphy, another study examined the effects of early and immediate loading on bone metabolism. Initially, bone metabolism increased during wound healing and then gradually decreased, returning to its baseline value regardless of load timing. But the increases in bone metabolic activity differed depending on when the implant was loaded: later load applications were found to be associated with higher bone metabolism11.

Finally, an 18F-fluoride PET-CT was used to evaluate bone metabolism in the residual mandibular ridges of three patients who were wearing free-end removable partial dentures. The study recorded an initial metabolic increase in bone beneath the denture, followed by a decrease after about three months. No bone structural changes were detected by clinical X-rays. It seems that bone metabolism is related to pressure caused by removable prostheses, but a metabolic balance is reached after an initial reaction. This suggests that bone remodelling involves a kind of metabolic equilibrium12.

11 Yamamoto et al. COIR 2014
Implantology needs periodontology

This session was hosted by the Société Française de Parodontologie et d’Implantologie Orale (SFPIO), the scientific society with whom the EAO collaborated for the 25th annual meeting.

Periodontal plastic surgery to prevent biological complications in the aesthetic zone

Caroline Fouque

Periodontal plastic surgery has been defined as the ‘surgical procedures performed to correct or eliminate anatomical, developmental, or traumatic deformities of the gingiva or alveolar mucosa’.

Biological complications can become aesthetic complications

The aesthetic outcome of implant restorations is highly dependent on the characteristics of the peri-implant mucosa. These, in turn, are affected by biological complications. This is important, as peri-implantitis may arise in one in five patients. The incidence of the condition is reported in 10% of implants and 20% of patients. A 5-year meta-analysis found that peri-implant mucosal recession occurred in 7.1% of cases.

It was recently stated that ‘the sooner the recession arises, the bigger our responsibility is’. This refers to the fact that early recession is generally caused by poor implant positioning or mishandling of the soft tissue, while later recession may be a consequence of biological complications involving more patient-related factors.

A clinical study of patients’ subjective perception of mucosal recession found that although the number of recessions was large in some instances, few were actually perceived by the patient (28%). Of these, only one third represented an aesthetic concern for which the patient requested treatment. This was due mainly to visibility, and was determined by the patient’s smile line type. In a multicentre study, it was concluded that assessments of gingival visibility should be performed during forced smiling rather than natural smiling.

Does tissue around implants and teeth have the same risk of recession?

Significant changes can occur in soft tissue levels following implant therapy. A 2-year clinical study of 106 implants in 39 patients found apical displacement of the peri-implant soft tissue margin of up to 1mm or more in 60% of cases.

Thin gingival biotypes are recognised factors influencing buccal recession in both teeth and implants. A direct correlation has been documented between thicker gingival tissues and greater peri-implant mucosal dimensions. However, the effect of gingival thickness on peri-implant tissue response is limited to facial gingival recession, and does not influence interproximal papillae or proximal marginal bone levels.

In a recent clinical study evaluating gingival thickness in 336 patients, more than two thirds of male patients were found to have thick gingiva, whereas the majority of female patients had thin gingiva. Further, it was observed that gingival biotypes in females could vary with age, unlike in males.

Recession may be due to the remodelling that takes place after implant surgery. This process is associated with a reduction in bone volume, especially in bone facial height and thickness. As a result, the mucosal margin may be apically displaced.

A prospective clinical trial comparing thick tissues and thin tissues alone, and thin tissues thickened with allogenic membrane, found that thin...
peri-implant tissues were associated with early bone loss\textsuperscript{11}. Regardless of statistical incidence, however, a careful examination of the biotype should be conducted, and tissue modification considered, when developing a treatment plan.

**Do implant procedures increase aesthetic risks?**
Following immediate implant restoration, mean buccal marginal mucosal recession of 1mm was observed in 40.5% of implant sites; only 14.3% exhibited no recession. In addition to tissue biotype, implants with a buccal position demonstrated three times more recession than implants with a lingual position\textsuperscript{12} (Figure 13.1.2). Proper implant positioning is perhaps the main factor in preventing soft tissue aesthetic problems.

**Do we need keratinised mucosa around implants to prevent inflammation?**
The width of keratinised mucosa (KM) is defined as the distance between the mucogingival junction and the free gingival or mucosal margin. Whether a minimum KM dimension is required for maintaining peri-implant health is a controversial topic, as various studies have reported opposing results.

The connective tissue fibres around implants run in a direction parallel or oblique to the titanium surfaces and do not attach to the implant. Further, tissue destruction in response to inflammation is more pronounced at implant sites than at teeth. Therefore it is logical that a certain amount of KM is beneficial, stabilising the peri-implant mucosa and increasing its resistance to pathological conditions or attacks.

Indeed, a recent systematic review has concluded that a lack of sufficient KM around dental implants is associated with increased plaque accumulation; tissue inflammation; and mucosal recession; as well as loss of attachment\textsuperscript{13}. The speaker recommended that adequate KM levels at implant sites be ensured from planning to execution.

**Thoughts on preventing recession around teeth and implants**
There are two types of clinical solutions: osseous and mucosal. Mucosal augmentation can be performed at different stages during the course of treatment. An interesting approach has been suggested which involves soft tissue grafting on the day of implant placement. This method attempts to convert both the morphology and behaviour of thin biotypes to those of thick gingival biotypes\textsuperscript{14}. Another prospective clinical study has reported successful augmentation of labial volumes using GBR and simultaneous implant placement, followed by connective tissue grafting\textsuperscript{15}.

With regard to teeth, several systematic reviews have demonstrated the efficacy of a coronally advanced flap to cover single and multiple gingival recessions. Even more effective was combining the flap with a connective tissue graft\textsuperscript{16}.

Implants generally exhibit more recession than teeth. A prospective cohort study of 10 patients revealed a substantial improvement of tissue levels at implant sites following coronal mucosal displacement in combination with connective tissue grafting. In none of the sites, however, could complete coverage of the implant soft tissue dehiscence be achieved\textsuperscript{17}.

Other studies achieved better results. One study involving 16 patients used tuberosities as donor sites and documented 89.6% mean coverage in single implant recessions, with full coverage among 56.3% of patients\textsuperscript{18}.

**Conclusions**
- periodontal plastic surgery can effectively prevent biological complications
- aesthetic soft tissue problems around implants are easier to prevent than correct
- treatment should focus on the thickness of the soft tissue
- performing a CTG during implant placement procedures is highly recommended

12 Evans & Chen COIR 2008
13 Lin et al. J Periodontol 2013
15 Schneider et al. COIR 2011
17 Burkhardt et al COIR 2008
18 Roccuzzo et al COIR 2014

\textbf{Figure 13.1.1} Tooth malposition
\textbf{Figure 13.1.2} Implant in a too buccal position

\textbf{“The sooner the recession happens, the bigger our responsibility is”}
\textbf{M. Roccuzzo, SFPIO congress, Lyon, 2016}
Bone management for optimal aesthetic outcomes
Nicolas Picard

Throughout his presentation, the speaker focused on biology, considering tissue morphotype; tooth extraction; healing processes; and subsequent bone resorption. He then outlined two therapeutic concepts: preservation and regeneration.

Biology

Tooth extractions in the aesthetic zone are known to be associated with dimensional alterations of the facial bone wall, which can have a profound effect on treatment outcomes. Further, it is recognised that immediate implant placement in a fresh extraction site often fails to prevent bone remodelling in socket walls.

Dimensional changes of the alveolus following tooth extraction were measured in an experimental study. Bone loss was found to occur mainly in the buccal bone plate and measured 2.2 ±0.9mm. A more recent study investigated the process of socket healing in monkeys. The study observed that levels of bundle bone decreased from 95.5% at 4 days to 76.8% at 180 days along the entire inner alveolar surface. Another study analysed socket healing using human biopsies. Tissue granulation was reported during the early healing phase and osteoblast levels peaked at 6–8 weeks, remaining almost stable thereafter.

The width of the buccal bone wall was measured by CBCT. At crestal levels, only 1% of incisors showed thick labial bone (1–2mm); 73% showed a thin bony wall (0.5–1mm); and 25% showed a very thin wall < 0.5mm. A 39-patient clinical study used a novel 3D approach for analysing two consecutive CBCTs and found that:

- a facial bone wall thickness of ≤ 1mm was a critical factor influencing the extent of bone resorption
- median bone loss of 7.5mm was registered in thin-wall phenotypes, compared with 1.1mm in thick-wall phenotypes. The results were statistically significant.

The same group of authors created 3D digital surface models by superimposing digital impressions and CBCT data. They measured dimensional changes of the soft tissue after extraction, and found that:

- at the moment of extraction, soft tissue thickness in both thin and thick bone biotypes were similar, averaging 0.7mm and 0.8mm respectively
- in thin bone biotypes, soft tissue thickness increased from 0.7 to 5.5mm after an 8-week healing period

- in thick bone biotypes, soft tissue thickness remained stable at about 0.8mm
- reduction in vertical tissue levels was similar, measuring 1.6 and 1.4mm respectively.

Ridge preservation vs. immediate implantation

Two recent systematic reviews have concluded that ARP procedures may limit post-extraction resorption, but cannot eliminate it completely. In addition, ARP does not promote bone formation within the socket, and instead the remnants of the graft appear to interfere with the healing process, retarding it. There is only limited evidence supporting the clinical benefits of ARP since implant placement feasibility; success rates; and marginal bone loss are comparable to those in untreated sockets.

An approach involving immediate implant placement combined with grafting the vestibular gap using DBBM (deproteinised bovine bone mineral) and a collagen membrane has been suggested. This has been shown to reduce bone resorption in an experimental study on dogs, from 2.7 ±0.5mm in control sites to 1.0 ±0.6mm in test sites. However, a similar study using the same animal model has found that the technique failed to maintain tissue volumes.

Vestibular bone dimensions in 14 patients were measured using CBCT seven years after immediate implant placement. It was found that five patients had no buccal bone at all and showed a mean vertical bone loss of 8.7mm. The other nine exhibited a vertical loss of 0.1mm, but the bone was just thick enough to cover the implant surface. Mucosal levels were 1mm more apical in implants with no bone present.

According to two systematic reviews, in order to prevent mid-facial recession in immediate implant placement (Figures 13.2.1–13.2.6):

- patient selection should be based on a thick bone and soft tissue biotype
- the buccal bone wall must be intact
- the implant should be placed palatally
- immediate placement of a provisional crown is strongly recommended

Finally, a recent prospective 5-year clinical study evaluated the aesthetic outcome of 22 single immediate implants. It concluded that: with an aesthetic complication rate of 8/17 in well-selected patients who had been treated by

- 26 Caneva et al. 2012
- 27 Favero et al. COIR 2015
- 28 Benic et al. COIR 2011
- 30 Benic et al. COIR 2011
experienced clinicians, type I placement may not be recommended for daily practice.\textsuperscript{31}

**Regeneration**

A review of the literature\textsuperscript{32} suggests there is evidence that early implant placement (Type 2) after soft tissue healing is associated with a lower incidence of recession when combined with GBR procedures using DBBM (Figures 13.2.7 and 13.2.8).

Ridge augmentation procedures are proven to be effective in treating bone defects prior to or at the same time as implant placement. The speaker concluded that GBR can be considered as the most predictable technique in terms of bone management for aesthetic outcomes.

\textsuperscript{31} Cosyn et al. J Clin Periodontol 2016
Things we stopped in our practice due to failures

In this session, four different issues were addressed: immediate implant placement; prosthodontic rehabilitation of edentulous jaws; immediate CAD/CAM restorations; and cemented fixed restorations. These different topics have a common denominator: they are all clinical protocols that have been subject to a change of opinion due to failures.

Immediate implant placement
Mariano Sanz

Can we influence socket healing with immediate implantation? (Figure 14.1.1)
There are some biological risks we cannot prevent. A recent histometric comparison between the spontaneous healing of a fresh extraction socket and immediate implant placement in the extraction socket recorded higher vertical bone loss in cases involving immediate implantation, and a tendency towards greater buccal horizontal resorption. The author’s conclusion was that immediate implant placement can jeopardise spontaneous bone remodelling in the socket.

In clinical scenarios, this biological factor is translated into a substantial reduction in peri-implant tissue volume in immediate implantation. In one study, the horizontal and vertical spaces between the implant and the bone wall were reduced by 63–80% and 65–69% respectively. Bone resorption levels are lower in posterior teeth and in cases involving thick biotypes, as well as in cases where the implant is placed immediately in palatal and apical positions (Figures 14.1.2 and 14.1.3). Although immediate implantation has no influence on final implant survival rates, there is an aesthetic risk of marginal buccal recession in about a quarter of patients.

Are there clinical solutions that can lower the risks of immediate implant?
Several clinical approaches have been used to try to counteract this kind of resorption:

1 Discepoli et al. COIR 2014
2 Sanz et al. COIR 2009
3 Tomasi et al. COIR 2009
4 Lang et al. COIR 2010
careful extraction of the hopeless tooth
perfect horizontal and vertical positioning of the implant
grafting the gap with a slow resorption biomaterial
increasing the thickness of the soft tissue
performing immediate provisionalisation

Together, these procedures have the capacity to partially reduce hard and soft tissue resorption.

What are the practical implications?
Outside the aesthetic zone, immediate implantation seems to be a reliable method for reducing treatment time: the number of surgical procedures is reduced, and it is a comparatively more comfortable treatment for both patient and dentist. It has been reported that in cases involving upper premolars, 71% of patients experienced no bone loss, and a small gain was even recorded in the soft tissue margin (Figure 14.1.4).

The key decision factors for immediate implantation are:
- socket integrity
- thickness of the socket bone wall
- patient aesthetic requirements

Immediate implant placement is a technically demanding procedure. The surgeon must avoid placing the implant in a non-optimal vertical or buccolingual position, and must achieve good primary stability. Great care must be taken to assess the socket anatomy, especially in compromised aesthetic areas.

Vignoletty & Sanz Periodontology 2000, 2014
Sanz et al. COIR 2016
Sanz et al. COIR 2013
**Prosthodontic rehabilitation of edentulous jaws**

*Karl-Ludwig Ackermann*

**A complex problem which is often insufficiently planned**

The successful rehabilitation of an edentulous patient depends on various factors, such as residual bone volume and inter-arch relationships. The restoration must meet the functional requirements of the patient, and should:

- be suitable for speaking and chewing
- have enough room for tongue function
- not entrap food debris
- be designed so it can be maintained by the patient (for example, be easy to clean)
- fulfill the patient’s aesthetic expectations

A treatment plan which is based on and tailored to the patient’s individual needs is vital.

**Length of clinical experience**

The speaker has 35 years of clinical experience, and illustrated several cases he has encountered which involved edentulous patients presenting with varying degrees of jaw atrophy. From these cases, he was able to share several conclusions:

- the fit of a framework is key in avoiding technical problems
- passivity is essential to prevent screw loosening
- generally speaking, bar retention performs better than ball attachments (Figure 14.2.1)
- milled bars are technically superior to cast bars, as retention clips need to be changed less frequently
- titanium galvano-telescopic restorations work fairly well, and are the ideal solution for cases involving implants which coexist with periodontal teeth, since occlusal forces are concentrated on the implants rather than on the teeth (Figure 14.2.2)
- zirconia telescopic restorations, however, are not as reliable, as they often suffer fatigue fracture (Figure 14.2.3)
Immediate CAD/CAM restoration

Margareta Hultin

The beginnings

For two decades, digital techniques in implant dentistry have been evolving, and can now offer high levels of precision. It is now possible to immediately install a full arch fixed prosthesis made by CAD/CAM, using minimally invasive flapless guided surgery to optimise implant positioning. The benefits for patients are clear: minimal invasiveness; a single surgical intervention; and required treatment time of as little as an hour. In 2002 Professor van Steenberghe and colleagues published their experiences of using this procedure to place final prosthetic reconstructions in eight patients7 (Figure 14.3.1).

Several systematic reviews have evaluated clinical performance of static guided implant placement and immediate loading in edentulous jaws at minimum 1-year follow-up. These reviews concluded that although the number of patients was still limited, survival rates were similar to those of conventional treatment8.

Such great outcomes ... so why did we stop?

The reviews also reported clinically relevant inaccuracies which led to intraoperative complications, both surgical and prosthetic. The overall rate of complications was found to reach 36.4%, even though the majority of studies involved provisional prostheses where the existing dentures were adapted to the inserted implants after surgery.

Factors influencing the accuracy of the procedure arise at every step9 (Figure 14.3.2):

- **examination**: patient movement during scanning; deviations of impressions and models; fabrication and fit of scan prosthesis
- **planning**: positioning implants using the software; issues relating to CT scanning; errors in model and guide production
- **execution**: transferring from planning to the operative field remains the most difficult part

Any number of these errors can arise, and cumulatively produce deviations in the maxillary and mandibular arch equally. Fixing the template with pins did not substantially mitigate variations. In some cases, variations in the implant apex positions were significant, and should be taken into account when planning treatment.

So what can we conclude?

A comparison of guided and freehand implant placement reveals that the former is superior to so-called ‘mental navigation’10. Guided surgery allows operators to use prefabricated restorations for immediate function, but also comes with risks of complications and deviations, prevents the restorations from being definitive (Figure 14.3.3).

7 Van Steenberghe et al. IJOMI 2002
9 Vercruyssen et al. COIR 2015
Cement-retained restorations

Konrad Meyenberg

Facts that make us think
After a period when the majority of implant restorations were screw-retained, cemented retention on simplified abutments became more popular again. Cementation is widely used by prosthodontists because of its simplicity; capacity for hermetic sealing; passive fit; and favourable aesthetic appearance.

However, cement-retained restorations are often associated with mucositis and peri-implantitis, due to open margins and cement excesses (Figure 14.4.1). Cement-retained crowns with a poor marginal fit can cause significantly more crestal bone loss – even in tissue-level implants – than well-fitting crowns after a mean of 3 years\(^\text{11}\). Increased incidences of inflammation are found in cases where there is an excess of cement around the restoration\(^\text{12}\). This is especially the case in aesthetic areas, where the abutment finishing line is generally lower and cement excess may be displaced subgingivally, where it is difficult to remove\(^\text{13}\).

Facts associated with intraoral cementation
Fact 1. Various techniques have been developed to avoid the excess of cement, such as dual cord application in the sulcus; venting the crown; or using a practice abutment. These techniques have been demonstrated \textit{in vitro}\(^\text{14}\), but currently lack definitive conclusions

Fact 2. A high number of cemented restorations exhibit excess cement in the peri-implant sulcus\(^\text{15}\)

Fact 3. Excess cement has been associated with signs of peri-implant disease 81% of cases\(^\text{16}\)

Fact 4. The frequency of undetected excess depends on the type of cement used, and is significantly greater in methacrylate cements than in ZOE cements\(^\text{17}\)

Fact 5. Removal of excess cement is difficult. Well-trained clinicians were only successfully able to remove excesses of ZOE cement from models\(^\text{18}\)

Fact 6. The retentiveness of luting agents varies\(^\text{19}\)

Fact 7. The retentiveness of provisional luting agents is less predictable\(^\text{20}\)

Fact 8. The interface between abutment, cement and suprastructure in the subgingival region is a critical area, offering ideal conditions for the formation of biofilms near the crestal alveolar bone. Higher levels of bacteria accumulating on cement lines have been demonstrated \textit{in vitro} than on machined titanium surfaces\(^\text{21}\)

To conclude: forget cementation
A comparison of the clinical performance of screw- and cement-retention reveals no significant differences. However, screw-retained reconstructions exhibit fewer technical and biological complications overall than cement-retained ones\(^\text{22}\). Technical complications are partially dependent on the systems used.

Fact 9. Occlusal discontinuity of access holes in screw-retained crowns may affect their resistance

Fact 10. Screw retention has the potential for reintervention (Figure 14.4.2)

The speaker recommended that we forget cementation, even though screw-retained reconstructions are more technically complex. For example, a passive fit is crucial for preventing mechanical problems in reconstructions on multiple abutments, and it is advisable to convert conical connections to flat non-locking ones in order to facilitate passivity (Figure 14.4.3).

13 Linkevicius et al. COIR 2011; Linkevicius et al. COIR 2013
14 Begum et al. IJOMI 2014
16 Wilson et al. J Periodontol 2009
18 Behr et al. IJOMI 2014
Debate: ‘machined or rough implants?’

This session explored whether the advantages of rough implants outweigh the increased risk of biological complications.

Machined vs. rough implants: 30 years of experience

Massimo Simion

Historical vision

The ‘golden age’ of osseointegration lasted from 1980, when machined implants were first used extensively, until around 2000. From then onwards, modified surfaces were introduced to the market, and at almost exactly the same time, a tsunami of peri-implantitis hit. The Estepona Consensus defines peri-implantitis as an infection involving suppuration and progressive bone loss1.

Studies from the ‘golden age’

A recent 20-year follow-up study documented survival rates for machined implants of 99.2%, with mean marginal bone loss around implant sites of less than 2mm and a prevalence of biological complications of 2.4%2. Another clinical study showed a cumulative survival rate (CSR) of 93.35%; mean marginal bone loss of 0.78mm; and no incidences of peri-implantitis after 12 years of follow-up3. A retrospective study of machined implants in native bone – with a mean follow-up period of 15 years – recorded a CSR of 96.8%, with peri-implantitis in 1.3% of cases. The behaviour of machined implants in augmented bone differs slightly: another recent retrospective study documented a similar CSR at 13–23 years of follow-up, but an incidence rate of peri-implantitis of 9.9%4.

Studies in the middle of the tsunami

With regard to vertical augmentation, a retrospective study of 88 patients and 246 implants with 15 years follow-up revealed rapidly progressing bone loss in 28.5% of 105 implants.5

Close-up images of implant surfaces provided by a scanning electron microscope (SEM) may explain the difference in these results. A hypothesis could be that rough implant surfaces are more susceptible to microbiota, with microscopic pathogens adhering to the surface, leading to resorption and higher levels of marginal bone loss around the implant.

5 Simion et al. in progress
Clinical advantages of modern micro-rough implant surfaces

Daniel Buser

An alternative historical vision
It may be that the ‘golden age’ of osseointegration was not so golden. In the 1990s, patient morbidity was improved when the use of modified surfaces with high osteophytic potential became widely used:

- shorter implants reduced the need for procedures like sinus floor elevation and vertical ridge augmentation, and bicortical stabilisation became obsolete
- early failures were reduced through submerged or non-submerged healing
- healing periods and overall treatment times became shorter, with immediate and early loading between 4–8 weeks
- equal success rates were achieved in the maxilla and mandible, even in areas with low density bone

After a development phase that lasted about two decades, there was a paradigm shift towards micro-rough surfaces in the late 1990s. Implant surfaces with a roughness measuring between 1–2μm achieved higher bone-implant contact levels and better removal torque values in experimental settings. This was soon translated into clinical data.

The most recent advance has been the shift in focus from topography to chemistry. After in vitro and in vivo preclinical studies, the introduction of the SLActive surface has further shortened healing times to as little as three weeks.

Clinical long-term documentation of micro-rough surfaces
The late failure rates recorded at 10 years make up less than 5% of the cases reviewed by Albrektsson and colleagues in 2013. The speaker himself has published a retrospective study of 511 implants in 303 patients, recording a survival rate of 98.8% and success rate of 97% at 10 years. These figures clearly differ from those documented in a recent study of the patient cohort treated from 1986–88 with titanium-plasma sprayed (TPS) implants, where the success rate is 75.8% at 20 years.

‘Why has there been such good long-term success at the University of Bern?’ the speaker asked. He said that it is because of several factors:

- all the studies featured tissue-level implants
- all studies followed strict surgical principles with circumferential bone anchorage
- each patient entered a supportive care programme

Poor treatment quality leads to a higher risk of peri-implantitis
Although the topic is controversial and the exact definition of peri-implantitis is disputed, the main causes of peri-implantitis seem to be:

- poor surgical technique (such as lack of buccal bone wall; poor positioning of the implant; or overly aggressive technique)
- poor prosthetic procedures (excessive use of cement; use of prostheses which are difficult to clean; or poorly fitting components)
- lack of patient maintenance programmes

The shape and surface of the implant, including manufacturing quality, could also be considered a potential risk factor for peri-implantitis.

The typical outcome: rough area exposed to oral environment
If, after initial resorption, the rough implant surface is supracrestal, its porosity is more susceptible to oral biofilms.

Bone response to implant placement depends on several factors. In cases involving poorly positioned implants, initial bone resorption will be greater. In procedures involving vertical bone augmentation it is difficult to reach the bone level originally predicted exactly, and a few millimetres of rough surface usually remain supracrestally. It is also recognised that the position of the implant’s micro-gap and its characteristics influence the response and stability of peri-implant tissues. There are several arguments for using a hybrid (machined/rough) surface design or tissue-level implants.

The speaker concluded that the main influencing factor is treatment quality. Widespread placement of implants by unqualified or inexperienced individuals is a problem that must be addressed by all players: governments, universities, associations, med-tech companies, and so on.

Please give me back my smile! Decision-making in the aesthetic zone: challenge your speakers

How to manage complex cases in the anterior maxilla using a multidisciplinary approach

Team 1: Markus Hürzeler and Otto Zuhr

A good aesthetic result is an essential measurement of success when placing implants in anterior regions. However, achieving a result that is both aesthetically and functionally optimal in the maxillary anterior area is not straightforward. Tooth extraction in this area is widely associated with volume reduction, and it is often necessary to compensate for this reduction before implants can be placed.

When conditions are less than ideal, it can be especially challenging to place an implant where a single tooth is missing or needs to be extracted. In these unfavourable cases the evidence-base underpinning available treatment options is often limited. Although predictability is a key issue and evidence is often limited, the speakers conceded that sometimes careful and judicious use of less proven techniques may be considered, provided that the duration of their outcomes can be expected to last for at least 5–10 years.

The speakers presented some complex cases involving seemingly hopeless teeth which exhibited fractured posts and appeared extremely difficult to rebuild. The approaches they described might typically be considered as temporary, but their main objective was to delay implant placement and keep the tooth in the mouth for as long as possible.

In compromised cases, it is particularly important that the decision-making process takes the patient’s perspective into account. Currently there is a trend towards using patient reported outcome measures (PROMs) as a way of evaluating the success of treatment. Patients typically prefer fewer surgical procedures; less invasive treatment; and options that minimise postoperative pain. When planning treatment, an evidence-based approach which also takes these factors into account must be made. As a result, the speakers generally prefer microsurgical techniques as they are both minimally invasive and have the potential to offer improved results.

An interdisciplinary approach is usually the best solution, and as an example the speakers presented a case which used orthodontic extrusion to gain...
vertical bone. This protocol usually requires 6 to 12 months for tooth movement followed by a retention period lasting 6 months.

The next case they described featured staged treatment involving:

- extraction followed by a waiting period of 6 months to allow initial socket remodelling
- bone block augmentation, with double collagen membranes used to cover the block
- a 6–8 month healing period
- implant placement
- a ‘buttonhole’ incision made at the muco-gingival junction to passively advance the flap without reducing the depth of the vestibule

The speakers then described their novel ‘socket-shield’ technique. Currently, a follow-up of five years is available for a small number of cases, and initial results are promising. However, the speakers stressed that further scientific evidence to support the technique is required.

**Conclusions**

- every case in the aesthetic area must be considered difficult, especially if patient expectations are high
- the protocol for treating cases in the aesthetic zone depends on individual patients’ perspectives
- an interdisciplinary approach often provides the best solution. This may involve orthodontic treatment or a staged augmentation procedure
- it is generally advisable to keep the tooth in the mouth for as long as possible
Contemporary management of complex aesthetic dilemmas with an interdisciplinary approach

Team 2: Tidu Mankoo and Laura Frost

The second presentation outlined how to treat cases in the aesthetic zone using an interdisciplinary approach. The speakers discussed the use of regenerative periodontal treatment combined with orthodontics and implants. In cases involving compromised dentition, three challenges are frequently found:

- compromised structure
- compromised soft tissue aesthetics
- compromised periodontal environment

An interdisciplinary treatment plan can help overcome these obstacles.

Biology, form, function, aesthetics and precision must be addressed in complex cases. The speakers presented five clinical cases which they resolved taking these elements into account. Drawing on extensive clinical experience, they based their treatment plans on four aspects: dental, periodontal, occlusion and aesthetics.

**Case 1**

This case was treated in five stages:

- **control phase:** this was necessary to prevent periodontal inflammation; repair carious lesions; and perform endodontic treatment
- **corrective phase:** consisting of provisionals; orthodontics; surgical periodontics; bone and soft tissue correction; and implant placement
- **re-evaluation:** during which final adjustments are made to the provisionals in order to stabilise the positions of the teeth and the occlusion is fitted
- **definitive restoration:** during which a further evaluation is carried out
- **maintenance**

An 18-year follow-up has revealed good results (Figure 16.2.1). Factors influencing long-term outcomes are:

- bone
- soft tissue
- components (including implants, abutments and prosthetics as well as design, shape, surface and connection)

**Case 2**

The second case required hard tissue augmentation before the orthodontic treatment phase. After that, a soft tissue graft was performed, and then the implant and the provisionals were placed (Figure 16.2.2).

**Case 3**

The third case involved multiple recessions and required orthodontic intrusion as a first stage in resolving the aesthetic problems. All but one tooth was preserved. A single implant was placed and a soft tissue graft was carried out before the final rehabilitation (Figure 16.2.3).

**Case 4**

The patient in case 4 presented with severe periodontitis. An initial stabilisation phase was followed by orthodontic extrusion of the hopeless teeth. These were then extracted, and the extraction sites prepared for immediate implantation. A surgical and prosthetic protocol to preserve bone volume and thickness of the labial soft tissue was followed. The restoration was constructed on small bridges which were designed to facilitate maintenance (Figure 16.2.4).
Thoughts on immediate implants:
- wherever possible, a flapless technique is recommended. If a flap is necessary, bone substitute grafts should be used.
- place the implant towards the palate and avoid wide platform implants.
- anorganic bone bovine mineral (or similar) should be used in the gap between the implant and buccal wall of the socket.
- a connective tissue graft should be performed to thicken the tissue.

Case 5
The final case also involved orthodontic extrusion (which may usually last 3–6 months, then is retained for 3 months). The final restoration made use of the single and small bridges concept (Figure 16.2.5).

An approach using orthodontic extrusion has substantial benefits when compared with conventional treatments which are based on surgical reconstruction or hybrid prostheses:
- surgery is less invasive.
- prostheses can be more easily designed and fabricated.
- it offers biological and biomechanical advantages.
- it can provide improved stability.
- it facilitates good oral hygiene and ongoing maintenance.
- the phonetics are likely to be better.

But it also has limits:
- clinical attachment is needed.
- teeth must be viable.
- infection must be eradicated, or at least controlled well.
- orthodontic anchorage is required.
- the appearance of interdental papillae will not be perfect but ‘good’ at best.
- the patient must still have teeth in the affected areas.

The speakers concluded that the therapeutic approach they presented during the EAO conference in Barcelona nine years ago continues to be valid (Figure 16.2.6).
Coming soon…

The **EAO Online Library**, where you can enjoy unlimited access to:

- congress sessions and videos
- abstracts and ePosters
- the latest editions of Inspyred
- and much more!

Find out more at [www.eao.org](http://www.eao.org)