The state of the science and art of implant dentistry coupled with ever increasing patient expectations continues to challenge our profession. Osseointegration of dental implants is no longer considered the sole criterion of success. Patients routinely expect that their implant-supported restorations will simulate a natural tooth as closely as possible. Unfortunately, this may become a Herculean and often impossible task—frustrating everyone.

Interdisciplinary and realistic treatment embodies a team that shares an expanded vision of “what is possible.” This entails looking beyond each colleague’s specialty to craft a plan that is optimal, but reasonable for the patient. Ultimately, the pillars of success are built upon thoroughness, organization, and close communication in concert with the unique skills and experiences of each team member.

Course Outline

- Dental implants and the biology of the surrounding hard and soft tissues.
- Collaborative treatment planning (dentist, surgeon, and dental technician).
- The Straumann implant: Tissue- or bone-level?
- The edentulous patient—Overdenture or fixed bridge?
- Considerations in the esthetic zone.
- The role of provisional restorations (enhance and maintain gingival esthetics).
- The influence of crown contours on the free gingival margin.
- Zirconia anatomic abutments or CARES?
- Making the impossible, possible.
- Complications: The gift that keeps on giving and giving…
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## Selected articles

- A Novel Decision-Making Process for Tooth Retention or Extraction (Avila G)  
- The McGill Consensus Statement on Overdentures  
- Biologic Width Around Titanium Implants (Cochran D)  
- The Effect of Inter-Implant Distance on the Height of Inter-Implant Bone Crest (Tarnow D)  
- A Simplified Method to Develop Optimal Gingival Contours for the Single Implant-Supported, Metal-ceramic Crown in the Aesthetic Zone (Kinsel R, Capoferri D)  
- Implant-Supported, Metal-Ceramic Fixed Prosthesis for the Edentulous Arch (Kinsel R, Capoferri D)  
- Guidelines for the Rehabilitation of Complete Edentulism Using an Implant-Supported Metal Ceramic Prosthesis (unpublished) (Kinsel R)  
- The Positive Relationship Between Excess Cement and Peri-Implant Disease: A Prospective Clinical Endoscopic Study (Wilson Jr TG)  
- Effect of Implant Abutment Modification on the Extrusion of Excess Cement at the Crown-Abutment Margin for Cement-Retained Implant Restorations (Wadhwani C)  
- Long-Term Outcome of Cemented Versus Screw-Retained Implant-Supported Partial Restorations (Nissan J)  
- Adult Growth, Aging, and the Single-Tooth Implant (Oesterle LJ)  
- Rocatec Bonding (3M ESPE)
Indications for dental implants

- Full or partial edentulism.
- Resective osseous surgery surrounding natural teeth would result in the loss of bone height and/or width that may be necessary for future implants.
- Multiple unsuccessful endodontic therapy or poor retreatment prognosis.
- Prognosis of molar root resection versus extraction and implant restoration.
- Traumatic tooth loss.
- Extensive caries that are unresponsive to the established CAMBRA protocol.
- Questionable long-term restorability of a natural tooth.
- Orthodontic anchorage and temporary anchorage devices (TADs).

Treatment planning

- Elucidate the patient’s expectations and their restorative goals.
- Age and health of the patient and what are the alternatives to implant treatment?
- Evaluate prospective implant site(s) in three dimensions for possible augmentation.
- Radiographs (periapical, panorex, and/or CBCT).
- Is virtual implant placement software with a surgical guide needed?
- Are there potentially problematic anatomical structures at the implant site(s)?
- Are diagnostic casts mounted using facebow and centric relation record needed?
- Interproximal spacing between dental implants.
- Interocclusal distance with the opposing dentition.
- The soft tissue contours, especially in the esthetic zone.

Review of the literature

- The implant-crown (or abutment) interfaces are colonized by bacterial infiltrate.
- The alveolar crest resorbs from this bacterial colonization in an apical and lateral direction to re-establish physiological dimensions of biologic width.
- Teeth and implants have been shown to have similar biologic width dimensions.
- Connective tissue attachment adjacent to teeth has perpendicular insertion into the root surface, while the connective tissue contact adjacent to the implant is circumferential and without insertion onto the implant surface.
- This limits intra-implant papilla support and preservation of the alveolar crest.
- The microtopography of implant surfaces profoundly influences the biochemical cascade of cell-mediate osteogenic differentiation, as well as, the cellular response of adjacent hard and soft tissues.
- Rough implant surfaces accelerate bone apposition and increase the bone to implant contact percentage over machined (or smooth) surfaces.
- Micromovement (50-150 µ) facilitates osteogenesis, while macromovement over 150 µ increases the risk of fibroencapsulation and implant failure.
- Cross-arch splinted, multiple implants can be placed into immediate function without an increase of failures.
- Single implants with primary stability that are immediately restored are successful.
The SAC classification in implant dentistry (2007 Quintessence Publishing)

Straightforward
Mandibular overdenture (2 to 4 implants).
Posterior single implant restoration.
Posterior extended edentulism.
Anterior extended mandibular edentulism.
Mandibular anterior single implant restoration.

Advanced
Edentulous mandible with 4 to 6 implants for a fixed prosthesis.
Maxillary overdenture (2 to 4 implants).
Maxillary anterior single restoration.
Multiple maxillary anterior implants/restorations.

Complex
Edentulous maxilla for fixed prosthesis.
Maxillary single central incisor restoration.
Adjacent maxillary implant restorations.
Immediate loading of multiple implants.
All cases requiring bone/soft tissue augmentation.

The SAC assessment tool that evaluates the potential complexity of the individual patient’s restorative needs is available as a free app for ITI members for Apple’s iPad, which can be downloaded for free from the iTunes store (ITI members only).

Overdentures guidelines

“Overdentures are implant-retained, not implant-supported.”

All prosthodontic principles for conventional complete dentures are followed. Reinforce the overdenture with a metal framework to minimize fracture of the acrylic base. The diagnostic setup avoids interferences with optimal tooth placement. Avoid ball anchor retentions. Cylindrical retentive anchors (Locators®) may be less problematic. Four maxillary implants for open palate, if less consider a closed palate.


What is needed to use Locator abutments?
SCS Screwdriver #046.400
Inserting Device #048.416
Analog #048.198V4
Laboratory Set #048.189V2
Advantages of Locators® for implant-retained overdentures

Minimal height facilitates incorporation into the overdenture design.
Can correct divergences of implants up to 20°.
Self-locating design assists the patient’s insertion of the overdenture.
Dual retention up to 10° divergence of implants increases retention.
Different gingival heights relative to the varying tissue heights.
Can be relined using either intra- or extraoral techniques.

Options when implants deviate ≤ 10° (engages dual retentions)
- Translucent   (5 lbs)
- Pink          (3 lbs)
- Blue          (1.5 lbs)

Between 10° to 20° (engages only extracoronal retention)
- Green         (3-4 lbs)
- Orange        (2 lbs)
- Red           (1.5 lbs)

Proximal gingival embrasure contours
Implant restorations adjacent to periodontally sound teeth retain normal alveolar bone and papilla height. Proximal contact alterations are generally not needed. Adjacent implants often result in a flat alveolar bone and overlying soft tissue morphology. The patient may complain of food impaction and air escape. In the absence of optimal soft tissue, proximal crown contours need to be broader to close the space, however, effective oral hygiene may be compromised. Fixed bridges are more conducive to closing proximal embrasures with gingival colored porcelain, which is convex and facilitates optimal oral hygiene.
**Biologic width and dental implants**

The implantogingival junction was examined in the dog model. The sulcus depth, junctional epithelium, and connective tissue contact were measured. The mean values were 0.49 mm for sulcus depth, 1.16 mm for the junctional epithelium, and 1.36 mm for the connective tissue contact. The sum of these measurements was similar to the dimensions found adjacent to natural teeth.

Cochran DL. J Periodontol 1997;68:186-198

Equally important is the lateral component of biologic width. Approximately 1.4 mm laterally from the implant-crown microgap was found to be necessary to prevent bone loss and potential soft tissue recession.

Tarnow DP. J Periodontol 2000;71:546-549

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**Considerations in the esthetic zone**

Collaborative evaluation by the implant team is of upmost importance.
High or low smile line (facial display)?
Are there hard and/or soft tissue deficiencies that require correction prior to or during implant placement?
Should the prospective implant site be maintained or enhanced?
What is the gingival biotype? Thick versus thin (good versus challenging).
How to adapt the cemento-enamel junction of the natural tooth to the round circumferential implant shoulder?
Techniques that will favorably modify gingival contours.
Implant site hard and soft tissue augmentation.
Bone-level implant restorations.

**Zirconia: CARES (Computer Assisted REstorationS) or anatomic abutments?**

Is excessive deviation from the standard anatomic abutment required?
Laboratory costs for material and labor.
The skill of the dental technician versus the knowledge of the computer technician.
Time required for fabrication of the CARES abutment.
Should the dental technician fabricate an abutment analog for scanning or should everything be virtual?
Will everything become digital or is there room for another Henri Matisse?
Modified tissue-punch surgical technique

Advantages:
- Increases the volume of facial attached keratinized gingiva, which provides the potential for the restorative dentist to enhance the facial gingival frame.
- Less traumatic surgery with reduced morbidity (no full thickness flap).
- Conserves the crestal attached keratinized gingiva.
- Minimizes the disruption of the surrounding blood supply.
- Increases the thickness of the facial gingiva to create a “root” prominence.
- Increased facial AKG reduces the risk of apical migration of the facial gingiva.

The protocol:
- A half round, 5 mm diameter tissue punch defines the palatal extension of the implant coronal platform (A). A semi-lunar incision using a 15-C blade connects the mesial-distal points of the tissue punch (B), which retains crestal attached keratinized gingiva (AKG). The periosteum is released to the facial (C). As the implant is inserted, the excess crestal AKG rotates around the point of periosteal attachment and moves facial and coronal (D). This increased AKG provides the restorative dentist and dental technician a powerful tool to manipulate the soft tissue frame adjacent to the implant-supported restoration into the optimal esthetic position. Since this is a “blind” surgery, cone beam computed tomography and treatment planning software facilitates precise implant placement.
This case demonstrates the potential for a favorable gingival contour using the modified tissue-punch technique. Prior to implant placement, the free gingival margin facial to the interim partial denture was apical to the desired definitive contour (above). The modified tissue-punch technique moved the crestal AKG in a facial and incisal direction. This results in increased AKG thickness.

Using the master cast to delineate the cemento-enamel junction, the restorative dentist and dental technician dictate the desired position for the free gingival margin surrounding the definitive crown (below).

As a restorative dentist, what do I request from my surgical colleagues?
Collaboration with all members of the implant team.
Optimal 3-D implant positioning of the restorative platform (CBCT if needed).
Joint evaluation of virtual implant placement using treatment planning software.
Adequate bone support (preserve or augment).
Surgical techniques directed toward increasing the volume of facial attached keratinized gingiva.
The bone-level multi-base abutments
Ideal for screw-retained bridges and overdenture retentive bars.
Multi-base abutments can accommodate non-parallel implants and facilitates the
optimal location of the screw access hole.
30° cone and low occlusal height.
Straight-forward laboratory fabrication.
Allows for retrieval for repair or modification.
No cement that may be retained subgingivally.

Gingival porcelain considerations
Optimal esthetic results are possible when the horizontal deficiency is not visible at
the patient’s maximum smile.
Decreases the potential for food impaction.
Minimizes air escape during speech.
Supports lip contours.
Intaglio surfaces of pontics are convex to facilitate oral hygiene procedures.
Patient must understand that gingival porcelain will be required in the definitive
prosthesis prior to treatment.
Although advances have been made by ceramic manufacturers, precise simulation
of the patient’s gingiva is far more challenging than tooth-colored ceramics.
The design of the metal framework and porcelain application are complex and
require the skills of an experienced ceramicist
Guidelines for full arch, implant-supported, metal-ceramic fixed prostheses

The literature has shown that a dental arch consisting of 10 teeth, known as the shortened dental arch (SDA), is adequate for function, esthetics, and not related to temporomandibular joint problems. An implant-supported fixed prosthesis using the SDA arrangement reduces costs for the patient. Using the SDA, the typical sites for the maxilla are 6 implants at the sites of the central incisors, cuspids, and 5.5 mm distal to the first premolars. The mandible receives 4 implants at the sites of the cuspids and 5.5 mm distal to the first premolars. The definitive prosthesis contains the anterior sextant, bilateral premolars and first molars.

Additional implants are required for a prosthesis that contains 12 dental units. This arrangement also allows for separated fixed prostheses (e.g. four in the maxillary arch, three in the mandibular arch). It is important that the mandibular fixed prosthesis compensates for mandibular flexure. On opening, the mandible contracts medially, which becomes more pronounced distal to the second premolar position.

The connectors should be separated at the first or second bicuspid sites or at the midline. The maximum distal cantilever should not exceed 11 mm to reduce the risk of fracture of the pontic/abutment connector from occlusal overload.

Centric occlusion and centric relation positions should be ideally coincident. The TMJ apparatus should be within normal limits without contributory pathology. Clinicians have recommended group function occlusion, which would distribute occlusal forces over a broad surface. The hypothetical advantage is to compensate for the absence of proprioception and the inherent resilience of the periodontal ligament. However, to date, there have been no peer-reviewed randomized clinical studies that show what is the “proper” occlusal design for implant-supported fixed prostheses. Alveolar ridge growth occurs throughout life, therefore, the prudent practitioner should continually monitor occlusal changes during scheduled maintenance appointments, which may ameliorate the risk for porcelain fracture.

The staged-extraction protocol

Transition from terminal dentition to an implant-supported fixed prosthesis.
Retain only sufficient teeth to serve as abutments for interim fixed prosthesis, not in prospective implant sites.
Offers improved function and esthetics.
Extended evaluation of proposed final definitive prosthesis prior to delivery.
A fixed, interim prosthesis reduces potential impingement of the graft material.
The tooth-supported interim prosthesis is modified to an implant-supported, interim prosthesis on the day of implant placement and tooth extraction.
When possible, the protocol can enhance or maintain the soft tissue contours.
Lingual metal reinforcement is mandatory to minimize connector fractures.
The provisional prosthesis serves as a template for the definitive prosthesis.
Patient must know that this service is valuable and is charged for this service Interim fixed prosthesis abutment—ADA code D6793.
Interim fixed prosthesis pontic—ADA code D6253.
**Screw- or cement-retained restorations?**

**Advantages of Screw-Retained Restorations**
The fixed prosthesis is retrievable. Allows for extraoral repair or modification, however, application of porcelain to a metal-ceramic prosthesis that has been delivered for several weeks is high risk due to absorption of salivary fluids and catastrophic destruction of the porcelain when fired in the ceramic oven.
No risk of inflammation (mucositis or peri-implantitis) caused by subgingival retained cement.
Reduced risk of the restoration becoming unseated if there is limited interarch space.

**Advantages of Cemented Restorations**
Passivity of the prosthesis.
Relative ease of fabrication.
Adaptable to non-ideal implant placement.
No occlusal access holes allowing more control of the occlusal contacts with resistance to shear forces.
No bacterial influx between the filling material that is used to close the occlusal screw access hole.
Possible improved esthetics.
Is type of cement important (resin, glass ionomer, zinc phosphate, IRM, TempBond)?

**Cement and Peri-Implant Disease**
Pauletto N, et al. IJOMI 1999;14:865-868
Lang NP, et al. IJOMI 2004;19(Suppl.):150-154
Gapski R, et al. IJOMI 2008;23;943-946

Wilson Jr TG (Reprint is included)
Subgingival cement is associated with peri-implant disease. Clinical signs can occur up to 9 years following cementation. It is hypothesized that the rough surface inhibits removal of microorganisms. Mucositis is restricted to soft tissue. Peri-implant disease causes destruction of supporting bone. Type of cement used is not significant, although composite resin cement was most frequently used, while reinforced glass ionomer was present in only one case. Removal of cement eliminated clinical inflammation.
Complications—How may they occur?

Insufficient collaboration within the treatment team.
Limited skills, experience, or a cavalier attitude of any treating member (the implant team is only as capable as the less capable member).
Not adequately evaluating the prospective site(s).
Unfavorable and unanticipated 3-D implant placement.
Failure of the team to understand the relevant biology that affects bone and the overlaying soft tissue adjacent to the dental implant restoration.
Not utilizing state-of-the-art technology (CBCT and implant planning software).
Unrealistic patient expectations (Sorry, this is beyond our expertise!).
Multiple surgeries that compromise vascularity and regenerative surgery.
Unfavorable root angulation with limited proximal bone.
The cleft palate—Maxillary independent movement that may compromise full-arch fixed prosthetic solutions.
Asymmetric horizontal soft tissue defects challenge dental technicians expertise.

Porcelain fractures of implant-supported restorations occur at a significantly greater rate than tooth-supported restorations.
Fractures significantly associated with opposing implant-supported metal-ceramic restorations, bruxism, and no nightguard.
Opposing implant-supported restorations: ~7x greater odds of total fracture, 13x greater odds of major fracture.
Bruxism: ~7x higher odds of fracture and 5x higher odds of a major fracture.
No nightguard: 2x higher odds of fracture than those with nightguard.
Hypothesized reasons: Biomechanical and neurosensory differences.
Sensitivity and mobility of natural dentition not duplicated with implants.
Occlusal force required for threshold perception is ~9x greater for implant crowns compared with teeth.

Although slowly, the maxilla and mandible grow downward and forward relative to the cranial base throughout life. Teeth compensate for this alveolar movement by erupting or shifting positions. However, implant-supported crowns do not have this capability.
Lack of occlusion may cause vertical or proximal malposition of adjacent teeth relative to implant-supported crown.
What is frequency and should we inform patients that these changes may occur over the service life of their implant-supported crown(s) or fixed bridges?
Rocatec Plus™

Rocatec Plus powder combines aluminium oxide and silicon dioxide. Kinetic energy from air pressure (at least 2.8 bar) creates chemical bonds, which is known as tribochemistry. Rocatec Plus eliminates the need for macroretention. All metals, ceramics, hard resins (e.g. PMMA, epoxides) and composites can receive a silicate adhesive layer.

Indications for use:
Veneering of crowns and bridges with composite resin (Sinfony).
Veneering RPD clasps.
Veneering metal frameworks for overdentures.
Silicatises porcelain bonded restorations without HF acid.
Repairs to ceramic or composite veneers.
Increases bonding of adhesive bridges.
Characterisation of preformed teeth made of resin or ceramic.
Bonding of ceramic teeth to denture acrylic.

SEM pictures of a ceramic surface after coating with Rocatec Plus
(1000x)

SEM picture of silicon dioxide particles on a ceramic surface
(60,000x)
The silane molecules (on right) approach the silicatised inorganic surface, which is covered with hydroxide groups and water molecules.
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(Scientific publications regarding Rocatec from 3M ESPE are included).
Some final words

Think biologically

Never accept dogma

Consensus is not science

RPK 2011