Primary stability vs. viable constraint: A need to redefine

By Michael R. Norton, BDS, FDS, RCS(ED)

Any regular reader of the journal of Oral & Maxillofacial Implants or in- deed of any other publication on dental implants could not fail to have noticed how much attention has been focused on primary stability. The concept of primary stability is not new; indeed, as early as the 1970s, there were studies emphasizing the need to estab- lish mechanical stability to ensure un- interrupted healing of the bone. This was most evident in the orthopedic lit- erature as it pertains to hip prostheses.

By the 1990s, numerous reports were being published on immediate loading of dental implants, and the ground- breaking work by Neil Meredith on the application of resonance frequency analysis (RFA) came to the fore, with statements that achievement of implant stability was a prerequisite for long- term positive outcomes.

At the same time, Meredith recog- nized it was possible for clinically firm im- plants with poor axial stability to still be prone to failure. Of course, Brånemark recognized this in his early work, proposing as he did a period of submerged healing because of his con- cerns for any destabilization of the bone-to-implant interface during the early healing phase. However, today, all we recognize that such protective protocols are frequently unnecessary, with widespread acceptance of not only transmucosal healing but also immedi- ate temporization and/or loading.

So how do we define primary stability? The most simple definition is one of me- chanical friction between the implant and bone.

Certainly, we can all appreciate that this contrasts with secondary stability where secondary stability is achieved by biological integration, i.e., osseointegration.

The gradual shift from primary sta- bility to secondary stability is critically poised at around three weeks. This is seen to be the least stable time point where viscoelastic stress relaxation of the bone along with remodeling results in a loss of primary mechanical stabil- ity: but with an as yet poorly established degree of secondary stability or osseoin- tegration.

This is also apparent in RFA curves, which, like a heartbeat, always register a certain pattern in healthy bone that reflects this loss of stability at the third or fourth week, regardless of bone den- sity. That said, we still need to define what constitutes primary stability, i.e., that which sets it apart from biological in- tegration. As stated above, mechanical stability is one where a friction occurs between the implant and the surround- ing bone, giving rise to a resisting torque at time of insertion.

This resisting torque is proportional to the effort required to seat the implant or peak insertion torque; they are in essence one and the same and depend largely on the characteristics of the im- plant, the density of the bone and the differential size of the osteotomy as it pertains to the diameter of the implant.

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AAID: Digital implant dentistry isn’t the future

Digital implant dentistry is not the future. No, far from it. Digital implant dentistry is the here and now for dental implant practitioners.

From digital treatment planning and delivery to patient communica- tion, new technologies are changing the way dentists practice implant dentistry. The American Academy of Implant Dentistry will present a course titled "Implant Dentistry in the Digital World" in Baltimore from April 24-25.

In addition to offering 12 hours of C.E., the AAID is honoring Dr. Leon- ard Linkow, one of the pioneers of the field of dental implants, with a dinner on Friday, April 24.

The conference, which is co-hosted by the AAID’s Northeast and South- ern Districts, will be held at the Mar-riott Inner Harbor at Camden Yards in Baltimorle.

More information and registration is available online at www.aaid.com.

The following programs are among those to be included:

• "CBCT Implant Planning: Digital Solutions from a Laboratory Perspec- tive" (Joe “Ambrose” D’Ambrosia, CDT)

• "Reverse Engineering in Digital Smile Design" (Alain Méthot, DMD)

• "Innovations in Digital Implantol- ogy" (Gilbert Tremblay, DMD, FAAD, DABOI/ID)

• "Technology to Enhance Your Practice" (Marty Jablow, DMD)

• "Fixed Implant Prosthetic Considerations" (Shankar Iyer, DDS, MD, FAAD, DABOI/ID)

• "Planning the Rehabilitation of an Edentulous Arch" (Lou Dipede, DMD)

• "Soft-Tissue Management in Im- plant Therapy" (Scott Ganz, DMD, FAAID, DABOI/ID)

• "Innovations in Digital Implantol- ogy" (Gilbert Tremblay, DMD, FAAD, DABOI/ID)

• "Reverse Engineering in Digital Smile Design" (Alain Méthot, DMD)

• "Protocols to Avoid Complications and Failures with the New Digital Workflow" (Scott Ganz, DMD)

Established in 1951, the AAID is the only dental implant organization that offers credentials recognized by fed- eral and state courts as bona fide. Its membership, which exceeds 5,000, includes general dentists, oral sur- geons, periodontists and prosthodon-lists from across the United States and in 40 other countries. For more information, contact AAID at aaid@ aaid.com or at (312) 335-1520 or (877) 335-AAID (2245).
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Mathematically, it can be defined as follows:

\[ \text{Resisting torque} = P \times \text{Sin} (\theta) \times \text{Diameter} \]

Where: \( H = \) height of the implant cylinder and \( D = \) diameter of implant cylinder

\( P = \) Critical pressure on the bone

\( \mu = \) Coefficient of friction

The important factor in this equation is \( P \), the critical pressure on the bone, as high pressure results in unfavorable bone strain, particularly within the cortical compartment. However, the formula indicates that the resisting torque is proportional to the diameter (D) raised to the fourth power. If, for example, we use the same insertion torque for a 3 mm wide implant and a 6 mm wide implant, then the critical pressure \( P \) decreases four times lower for the wider implant.

For example, an implant of 3 mm diameter inserted into 1 mm thick cortical bone with a torque of 20 Ncm will transmit the same pressure to the bone as an implant of 6 mm diameter inserted into 2 mm thick cortical bone with a torque of 160 Ncm. This assumes that 100 percent of the torque originates from the pressure on the cortical bone, and the contribution to torque from bone cutting, etc., is negligible. Yet manufacturers persist in providing a single target value of insertion torque. It will, of course, take controlled effort to drive an implant successfully, and ISQ has been described as a good predictor of success. However, this is a chancy that has got me thinking and has led me to write this editorial page. Could it be that axial stiffness is far more pertinent than rotational friction in ensuring an implant integrates? We already know from the literature that an implant can tolerate a degree of micro-motion, thought to be around 0.1 mm. This and this is in essence what ISQ measures.

Studies have also demonstrated that insertion torque correlates closely to the degree of micro-motion. However, it is not the aim to seek complete elimination of micro-motion, a valuable lesson learned in orthopedics. If it is possible to place an implant with low insertion torque and still achieve axial stiffness with an ISQ >60, surely this provides us with a more optimal evaluation of primary stability.

Our goal must be the rapid onset of secondary stability, with minimal critical pressure to the poorly vasculated cortical bone so unfavorable to sensitive responses and delayed healing are avoided. At the same time, we need to employ an objective measure of constraint that reliably ensures the implant can tolerate early micro-motion. Much was recently proposed by Barewal et al.1,7 I have labeled this objective measure viable constraint (VC), whose central purpose is to obtain a clinically relevant degree of stability while maintaining a low critical pressure on the vulnerable cortical tissues through which our implants are inserted.

Bone is not wood. It is not inanimate. It would behoove us all to remember this, and avoid the carpenter’s approach to implantology. So I would take this opportunity to ask that we think in terms of viable constraint. It will, of course, take controlled prospective studies to determine the optimal conditions for VC, but if I were a gambling man (which I most certainly am!), I would guess for a 4.5 mm implant in bone that is one cortex thick in thickness that a maximum torque of 20 Ncm and an ISQ of 60 represent the optimal measures we are looking for to ensure safe immediate loading.

In the past, we used to think length was important with implants, whereas today there is increasing focus on short implants. However, I would point out that a strong correlation has been shown to exist between ISQ and implant length visible, and, as such, for immediate loading, I also believe a longer implant with a higher ISQ, inserted at a lower insertion torque, will yield a more favorable outcome.

References available upon request from the publisher.

Note

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He is past editor of the AO’s Academy News and is currently associate editor of the international Journal of Oral & Maxillofacial Implants (JOMI). He also serves as a referee for a number of other peer-review journals. From 1993 to 2010, he was joint owner and editor of the Journal of Dental Implant Summaries.

‘We need to employ an objective measure of constraint that reliably ensures the implant can tolerate early or immediate loading.’
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Bone regeneration through tissue engineering offers new prospects for oral procedures

Regeneration of bone tissue could greatly benefit people with jaw-bone deficiencies due to tooth loss, infection or trauma. While an ideal method of bone tissue engineering is not yet available, research with a collagen-hydroxyapatite-Mesenchymal stem cell composite is showing promise. Hydroxyapatite is the main component of bone mineral and tooth enamel. A report in the Journal of Oral Implantology details researchers’ efforts to synthesize a collagen-hydroxyapatite composite through mineralization of collagen fibrils with nanometer-sized apatite crystals.

Hydroxyapatite is the main component of bone mineral and tooth enamel. A report in the Journal of Oral Implantology details researchers’ efforts to synthesize a collagen-hydroxyapatite composite through mineralization of collagen fibrils with nanometer-sized apatite crystals. The biological properties of the composite were evaluated by culturing with mouse and human mesenchymal stem cells. The scaffold is an artificial structure that is combined with living Mesenchymal stem cells to form a tissue engineering construct that can repair or regenerate bone Mesenchymal stem cells, which can differentiate into a variety of cell types, are used to precipitate bone growth.

The current study tested three ratios of collagen to hydroxyapatite: 80:20, 50:50, and 20:80. Both the 80:20 and 50:50 composites supported attachments and proliferation of mouse mesenchymal stem cells and human periodontal ligament stem cells in laboratory tests. The 50:50 ratio had the best mechanical properties suitable for bone grafting applications. The authors report that these findings indicate a strong potential for collagen-hydroxyapatite composite complexes in bone tissue regeneration. The composites are porous and sponge-like, and show good biocompatibility and biomimetic properties.

Alveolar bone deficiency is a limiting factor for dental implant-supported prosthetic therapies. The effective formation of new bone offers a basis for further procedures to successfully repair teeth and jaws.


About Journal of Oral Implantology

The Journal of Oral Implantology is the official publication of the American Academy of Implant Dentistry. It is dedicated to providing valuable information to general dentists, oral surgeons, prosthodontists, periodontists, scientists, clinicians, laboratory owners and technicians, manufacturers and educators. The JOI distinguishes itself as the first and oldest journal in the world devoted exclusively to implant dentistry. For more information about the journal or society, visit www.joionline.org.

$1.5 million gift establishes first endowed professorship at UMSOD

The University of Maryland School of Dentistry (UMSOD) has received the largest one-time gift in the school’s 175-year history, a $1.5 million donation from alumni Frederick G. Smith, MS, DDS ’78, and Venice K. Paterakis, DDS ’81, that will establish the institution’s first endowed professorship.

This donation will provide resources to fund the work of the school’s distinguished faculty.

“As the world’s first college of dentistry, established in 1840, we celebrate our 175th anniversary this year. This historic gift pays tribute to the school’s illustrious past as a leader in dental and dental hygiene education while ensuring that the UMSOD will remain among the premier dental schools in the world,” said Dean Mark A. Reynolds, DDS ’86, PhD. “I speak for all of us here at the School of Dentistry when I express my heartfelt gratitude to Dr. Smith and Dr. Paterakis for their generosity.”
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Bringing innovation back
Nobel introduces a ‘complete posterior solution’

By Nobel Biocare Staff

Large extraction sockets, limited accessibility, tough-to-remove excess cement and high occlusal forces. These are just some of the challenges a clinician faces when restoring a single tooth in the posterior. And, with molar replacement being among the most common indications, these challenges are encountered repeatedly.

A solution that addresses all these problems in an efficient and predictable way will make life easier for dental professionals and patients. That’s precisely why Nobel Biocare is bringing innovation back to the posterior region with its new complete posterior solution — an original combination of new wide-platform implants and restorative options, all specially designed for molar sites.

An implant like no other

Multiple Nobel Biocare innovations combine to make this solution complete, but the foundation for treatment success is the implant itself. Here Nobel Biocare offers several options, each engineered for the specific demands of the posterior. All are intended to shorten time for the patient by enabling immediate loading whenever possible.

One option is NobelActive. Many clinicians are already familiar with this award-winning implant. Its distinctive design and the surgical protocol form a unique combination that can enable immediate function in cases where it might otherwise not be achievable.1,2,3

To condense bone gradually, its tapered body features threads that narrow towards the apex, while the apex itself features drilling blades to preserve bone by allowing a smaller osteotomy. These features are all designed for high primary stability, even in soft bone and extraction sockets.

Now, a new variant offers the benefits of the NobelActive family but with dimensions ideal for the molar region. NobelActive wide platform (WP) possesses a wider diameter implant body (5.5 mm) to better fit the large extraction sites in the molar region and a wider implant platform for an optimal emergence profile. NobelActive WP also comes in an option with a shorter body (7 mm) to avoid critical anatomical structures, such as nerves.

Stability and flexibility in parallel

Alternatively, clinicians can opt for NobelParallel Conical Connection (CC). Combining a parallel-walled implant body that is well documented with an advanced internal connection, NobelParallel CC offers extraordinary flexibility. It is engineered for use in all bone qualities and for a wide range of indications. The 5.5 mm wide platform option is designed for an optimized emergence profile for large molar sites. Both experienced clinicians and those early in their implant careers will appreciate NobelParallel CC’s straightforward surgical protocol. It offers flexibility and shortens treatment time, benefiting the patient too. Together, the surgical protocol and implant design form a unique combination that’s intended to allow immediate function in more cases by providing high primary stability. The thread design and tapered apex of NobelParallel CC are designed for underpreparation of the surgical site and bioconical anchorage — techniques that support immediate loading.4,5

High stability during the initial healing phase is then maintained by Nobel Biocare’s unique TiUnite surface.6 In addition, patented grooves enhance osseointegration7 for a predictable end result.

Connecting strength and flexibility

Both new implants benefit from Nobel Biocare’s internal conical connection. This advanced connection’s conical seal and hexagonal interlocking mechanism provide high mechanical strength.8 It offers restorative flexibility too, being compatible with Nobel Biocare’s most innovative restorative solutions, including those designed specifically for the posterior.

These include the new PEEK Healing and PEEK Temporary Abutments, which are anatomically shaped to match the molar contours. As the PEEK Abutments come ready-shaped for an optimized emergence profile, fewer adjustments are needed. This can simplify treatment and reduce costly chair time.

The crown that ‘rules them all’

When it comes to the final restoration, the FCZ (full-contour zirconia) Implant Crown is designed for strength and predictability even under the high occlusal forces of the posterior. There’s no worrying about chipping either, as the full-contour nature of the NobelProcera FCZ Implant Crown removes the need for veneering.

The biocompatibility of the materials used contributes to biological stability in the areas where it matters. Plus, being screw retained, the FCZ Implant Crown is completely cement free, avoiding the risks associated with cement excess entirely. Even the titanium adapter is mechanically retained.

The ability to use an angulated screw channel (ASC) allows the screw access hole on the FCZ Implant Crown to be placed anywhere between 0 and 25 degrees in a 360-degree radius. This means it can be angled towards the front of the mouth for easy access, even in the posterior. It also helps avoid placing the access channel on the cusp of a tooth, where it could affect occlusion. The associated Omnigrip Screwdriver further simplifies work on the restoration. Its effective pick-up function and secure grip on the screw help the clinician to work safely and efficiently.

Natural- looking tooth color is another benefit offered by the FCZ Implant Crown. Whichever of the eight available shades is used, the color is applied throughout the material. This means discoloration isn’t a concern when making adjustments. Cutbacks and staining can also be used to achieve the desired esthetic effect.

Several components, one complete solution

While each product within Nobel Biocare’s complete posterior solution stands out on its own, they stand stronger together. Like all Nobel Biocare innovations, they are tested together as one system, as they exist in the patient’s mouth.

Combining Nobel Biocare components means all elements are designed to work in synergy for the optimal treatment outcome. Restoring single molars represents a clinical challenge for many reasons, but now, by uniting new and proven innovations, Nobel Biocare has the answer.

Find out more at nobelbiocare.com/bringinginnovationback

References are available upon request from the publisher.
Straumann introduces a flexible collagen membrane that’s easy to handle and place

By Straumann Staff

Straumann is once again expanding its portfolio of regenerative solutions to better meet customer needs. Now, Straumann® Membrane Flex™ joins Straumann® Membrane Plus™, Straumann® XenoGraft, Straumann® AlloGraft, BoneCeramic™ and Emdogain™ to provide a single trusted source for dental implant and regeneration needs, according to the company.

A quick look at Membrane Flex
- Desirable handling characteristics.
- Because it’s not side specific, it’s easy to handle and to place.
- With outstanding flexibility, it easily drapes over defects and naturally conforms to contours.
- Flexibility as it can be easily repositioned for precise placement.
- Can be placed dry or hydrated.
- Even when hydrated, does not adhere to gloves or instruments.
- Takes sutures or tacks with ease, for simple yet secure fixation.
- Proven biomechanical strength enhances fixation assurance.*
- In pre-clinical testing, the suture pull out strength was three times higher than a similar product.*
- Because of its significantly higher suture pullout strength, can be firmly anchored to surrounding tissue with minimal risk of tearing or detachment.*

Supports wound healing
- Biocompatible because it’s meticulously manufactured from highly purified intact porcine collagen and minimal cross-linked for predictable resorption.
- Reduced degree of inflammation and foreign body response as compared to other similar products in pre-clinical testing.
- In pre-clinical testing, the suture pullout strength was three times higher than a similar product.*
- Because of its significantly higher suture pullout strength, can be firmly anchored to surrounding tissue with minimal risk of tearing or detachment.*

This new offering — along with other recent additions to the Straumann portfolio — is one of the latest products the company provides customers with for a total solution that yields patient satisfaction and practice success.

To learn more about the new Straumann Membrane Flex, visit www.straumann.us/bone/

* Data on file with manufacturer

Photo/Provided by Straumann

About Straumann
Headquartered in Basel, Switzerland, Straumann (SIX: STMN) is a global leader in implant, restorative and regenerative dentistry. In collaboration with leading clinics, research institutes and universities, Straumann researches, develops and manufactures dental implants, instruments, prosthetics and tissue regeneration products for use in tooth replacement and restoration solutions or to prevent tooth loss.
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