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_c.e. article
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A need to redefine

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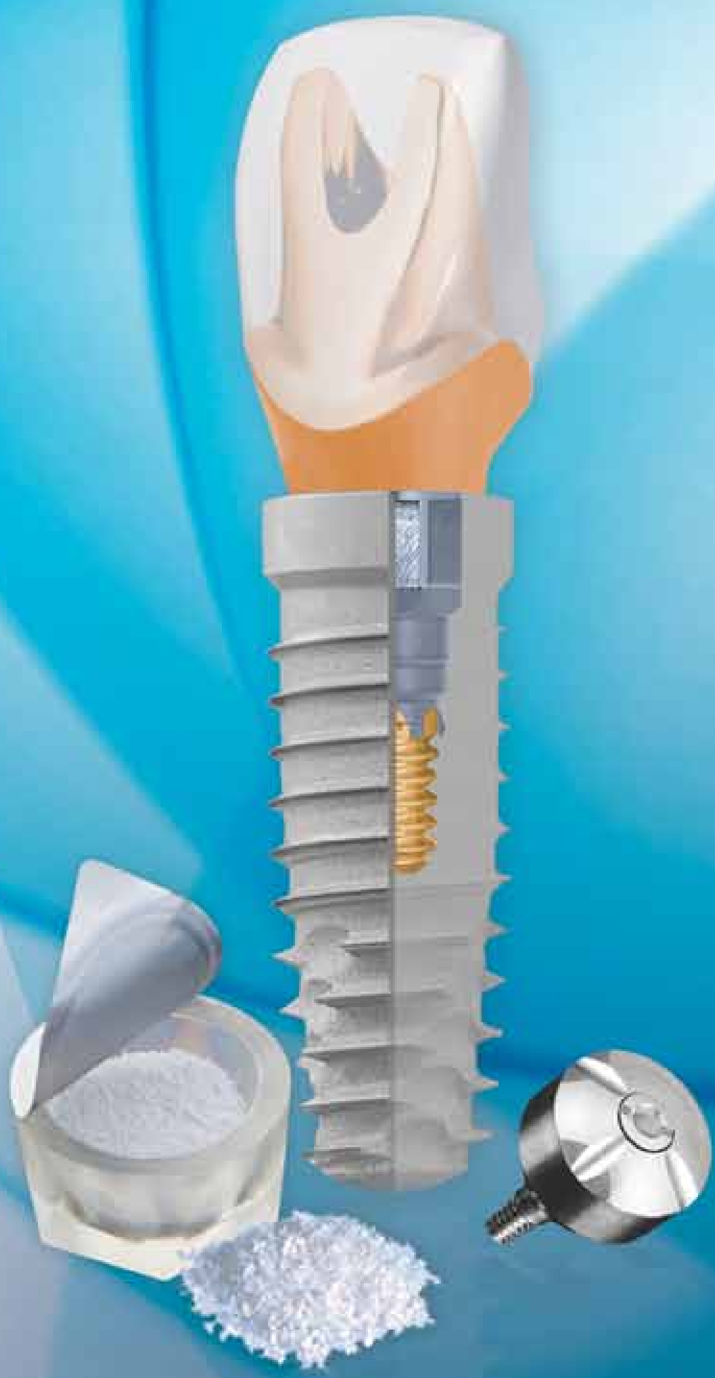


Stay on top of new techniques, products with *implants*

Torsten Oemus
Publisher
Dental Tribune International

_Thanks to continous advancing technology, the field of implant dentistry is always growing, changing and evolving. Clinicians need to be vigilant in their efforts to keep up with the new techniques, new products and new technology that could affect how they plan implant treatment.

That's just one reason the publication you are holding right now is so valuable.

As always, in this issue of *implants*, we've assembled a collection of articles from a variety of respected names and companies in dentistry. These expert clinicians are sharing their first-hand knowledge and expertise with you. In this issue, you can read about primary stability, and you can also learn about immediate implantation and provisionalization. We also have news on the latest implant events and technology.

But that's not all.

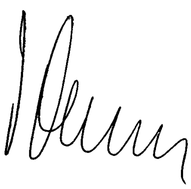
Every issue of *implants* magazine also contains a C.E. component. By reading the articles (beginning on Page 6) on "Primary stability vs. viable constraint: A need to redefine," by Dr. Michael Norton, and "Immediate implantation and improvisionalization: Single-tooth restoration in the esthetic zone," by Dr. Susan McMahon and Karrah Petruska, and then taking short online quizzes on the articles at *www.DTStudyClub.com*, you will gain one ADA CERP-certified C.E. credit.

Keep in mind that because *implants* is a quarterly magazine, you can actually receive four C.E. credits per year out of your already busy life without any lost revenue and time away from your practice. To learn more about how you can take advantage of this C.E. opportunity, visit *www.DTStudyClub.com*.

Finally, if you are interested in becoming a published author, we are always looking for experienced clinicians to write C.E. articles and offer their expertise to our readers. Contact Managing Editor Sierra Rendon at *s.rendon@dental-tribune.com* for more information on submitting an article.

I hope you enjoy this issue of *implants* and that it enhances your daily life in the dental office.

Sincerely,



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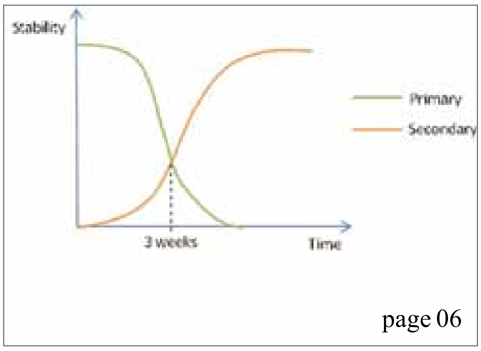

page 06


page 10


page 15

c.e. articles

education

events

industry

about the publisher

on the cover

Cover image provided by BIOMET 3i


page 18


page 22


page 24

Primary stability vs. viable constraint: A need to redefine

Author_Michael R. Norton, BDS, FDS, RCS(Ed)

_c.e. credit part I

This article qualifies for C.E. credit. To take the C.E. quiz, log on to *www.dtstudyclub.com*. Click on 'C.E. articles' and search for this edition (Implants C.E. Magazine — 1/2015). If you are not registered with the site, you will be asked to do so before taking the quiz. You may also access the quiz by using the QR code below.

_Any regular reader of the Journal of Oral & Maxillofacial Implants or indeed 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 establish mechanical stability to ensure un-interrupted healing of the bone.[1] This was most evident in the orthopedic literature as it pertains to hip prostheses.[2]

By the 1990s, numerous reports were being published on immediate loading of dental implants,[3-6] and the groundbreaking work by Neil Meredith on the application of resonance frequency analysis (RFA) came to the fore[7-9] with statements that achievement of implant stability was a prerequisite for long-term positive outcomes.

At the same time, Meredith recognized it was possible for clinically firm implants with poor axial stability to still be prone to failure.[8] Of course, Brånemark recognized this in his early work, proposing as he did a period of submerged healing because of his concerns for any destabilization of the bone-to-implant interface during the early healing phase. However, today, we all recognize that such protective protocols are frequently unnecessary, with widespread acceptance of not only transmucosal healing but also immediate temporization and/or loading.

So how do we define primary stability? The most simple definition is one of mechanical friction between the implant and bone. Certainly, we can all appreciate that this contrasts with secondary implant stability where secondary stability is achieved by biological integration, i.e., osseointegration. The gradual shift from primary stability 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 stability[9] but with an as yet poorly established degree of secondary stability or osseointegration.

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,[10] regardless of bone density.

That said, we still need to define what constitutes primary stability, i.e., that which sets it apart from biological integration. As stated above, mechanical stability is one where a friction occurs between the implant and the surrounding 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 implant, the density of the bone and the differential size of the osteotomy as it pertains to the diameter of the implant. Mathematically, it can be defined as follows:

$$\frac{\text{Resisting torque}}{2} = \mu * P * H * \pi * D2$$

Where: $H * \varpi * D^2$ = surface area of implant in contact with bone, where H = height of the implant cylinder and D = diameter of implant cylinder

P = Critical pressure on the bone

μ = Coefficient of friction

The important factor in this equation is P, the critical pressure on the bone, as high pressure re-

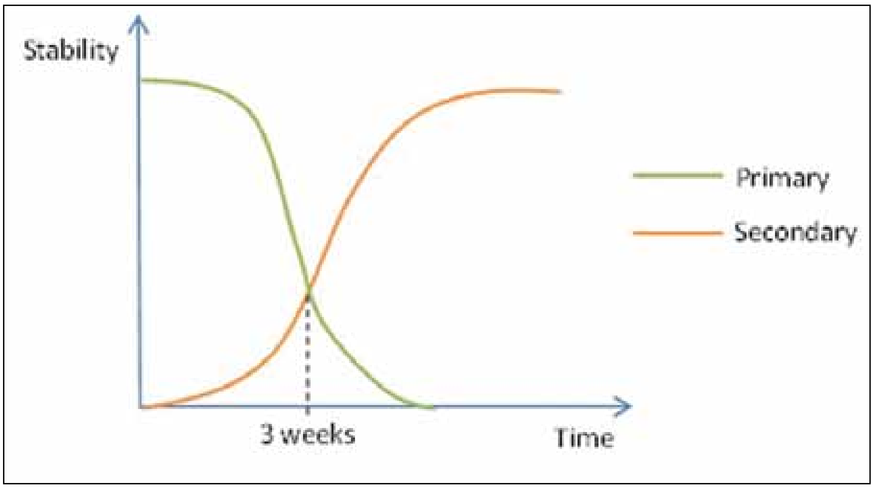

Fig. 1

sults 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 power of 2. This means that if you double the diameter the resisting torque becomes four times higher. Put another way, if we use the same insertion torque for a 3 mm wide implant and a 6 mm wide implant, then the critical pressure P will be 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 neglected). Yet manufacturers persist in providing a single target value of insertion torque across the range of implant diameters they offer.

It is therefore reasonable to discuss the virtues of insertion torque and ask the pivotal question: Is insertion torque an appropriate measure by which to quantify optimal primary stability? After all, bone is a living tissue, so any measure of primary stability must also reflect the future viability of the bone.

It is clear that higher insertion torques fulfil the desire to achieve a high degree of mechanical stability as interpreted through manual perception. Indeed, it is usual for manufacturers to provide some guidance on optimal insertion torque with some implant designs being specifically tailored to deliver higher insertion torques, in excess of 75 Ncm. This yields a sense of comfort for the clinician that the implant is initially "stable."

However, such a high torque has not been shown to be propitious to the surrounding bone. Numerous studies have been published that clearly demonstrate that the critical pressure these high torques create leads to micro-fracture of the bone,[11,12] with a net resorption in the cortical zone[11,12,13] and, indeed, an unfavorable delayed healing process with a reduced bone-to-implant contact.[14] Such a response might well shift the onset for secondary stability and thereby delay or extend the period of potential vulnerability. This is clearly counter to the goal we are trying to achieve with immediate or even early loading protocols, whereby we want to transfer from simple mechanical fixation to full osseointegration in the shortest possible time.

The most fascinating aspect of this debate is the lack of correlation between insertion torque and the implant stability quotient (ISQ) as measured by RFA, which appears to be counterintuitive. How is it possible for an implant that is driven in at 30 Ncm to have the same ISQ as one that required 100 Ncm of torque? Nonetheless, the weight of literature would seem to suggest this to be the case.[15-18]

Because ISQ is measuring axial stiffness, it must be clear that frictional rotational resistance is a completely different parameter. After all, I don't doubt we have all have experienced the "spinner" (an implant that exhibits little or no rotational stability) that went on to osseointegrate, and there are a number of studies published that report high success rates for immediately loaded implants that were inserted with low insertion torque.[19-22]

By contrast, implants with an ISQ of less than 50 rarely go on to integrate successfully, and ISQ has been described as a good predictor of success.[23, 24] It is this dichotomy that has got me thinking and has led me to write this editorial piece. 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 circa 100-

Academy of Osseointegration

At the AO Annual Meeting

Dr. Michael R. Norton will be presenting at the Academy of Osseointegration Annual Meeting, March 12-14 in San Francisco, as part of the restorative track. His presentation — "Controversies in Assessing Implant Stability: Is Tight Right?" — will take place on Friday, March 13, from 11–11:30 a.m.

This presentation will consider evidence in relation to the use of high insertion torques to deliver high primary stability and whether this is based on any clinical or biological validation that it guarantees higher success or delivers greater predictability in osseointegration, in particular as it relates to immediate placement and immediate loading.

Objectives: Upon completion of this presentation, participants should be able to: 1) define primary stability; 2) discuss the impact of high insertion torque on the bone/implant interface and whether this enhances or prohibits favorable bone healing; 3) provide a proposed protocol for delivering optimal primary stability from both a mechanical and biological perspective; and 4) recognize that the goal in implant dentistry is not primary stability but early onset secondary stability with optimal bone response.

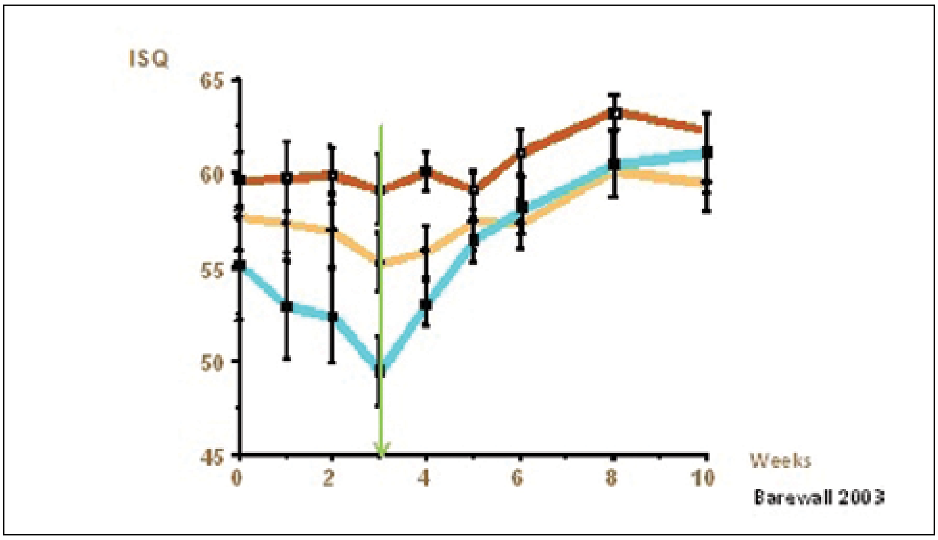

Fig. 2

150µm,[25, 26] and this is in essence what ISQ measures.

Studies have also demonstrated that insertion torque correlates closely to the degree of micro-motion.[25] However, it is not the aim to seek complete elimination of micro-motion, a valuable lesson learned in orthopedics.[27] If it is possible to place an implant with lower insertion torque and still achieve axial stiffness with an ISQ $\geq$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 vascularised cortical bone so unfavorable resorptive 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 or immediate loading. As much was recently proposed by Barewal *et al*[17].

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 implant dentistry.

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 with a cortex of <1.0 mm 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[28,29,30] 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.

_Note

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_about the author

Dr. Michael R. Norton, BDS, FDS, RCS(Ed), graduated from the University of Wales, School of Dental Medicine, in 1988. He runs a world-renowned practice dedicated to implant and reconstructive dentistry in Harley Street, London. He is a specialist in oral surgery and, in 2007, was awarded a prestigious fellowship of the Royal College of Surgeons, Edinburgh, without examination, for his contribution to the field of implant dentistry. In 2013, Norton was made adjunct clinical professor to the Department of Periodontology at the Ivy League Dental School at the University of Pennsylvania.

For more than 20 years, Norton has led the way for implant dentistry in the United Kingdom, becoming one of the world's most respected and renowned implant surgeons. His considerable portfolio of research has been groundbreaking, and he has become one of the most sought after lecturers in his field. Since 1989, Norton has dedicated all his clinical and postgraduate time to the practice and study of implant reconstructive dentistry. He is secretary, board member and fellow of the Academy of Osseointegration (AO) and is past president (1999-2001) and honorary life member of the Association of Dental Implantology (ADI), UK. 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.

Norton is widely published in the literature including one of the earliest Quintessence textbooks on the subject published in 1995. From 1995 to 2010, he was joint owner and editor of the journal Dental Implant Summaries.