An Evidence-Based Endodontic Implant Algorithm: Back to the Egg; Concluding Part

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A n increased uniform amount of coronal dentin significantly amplifies the fracture resistance of endodontically treated teeth, regardless of the post system used or the choice of material for the full-coverage restoration. A recent article by Coppede et al. demonstrated that friction-locking mechanics and the solid design of internal conical abutments provided greater resistance to deformation and fracture under oblique compressive loading when compared to internal hex abutments. These two "seemingly" disparate observations define the inherent continuum between natural tooth engineering and the principles of engineering necessary to orthobiologically replicate the native state.

The use of a ferrule or collet and a bonded or intimately fit post-core to restore function and form to an endodontically treated tooth is analogous to the use of a long, tapered friction fit interface with a retaining screw (Morse taper), to secure an abutment to a tooth. Architects and engineers have used smooth oval curves to support the weight of structures over an open space literally since the second millennium BC. These arches, vaults and domes can be extended, should fit into the peripheral support single crowns with cantilevers instead of implant/implant or implant/teeth connections for a span of any degree. These engineering design iterations will minimise high-stress torque load at the implant abutment interface and obviate areas with degrees of bone insufficiency.

The goal should be to biomimetically replicate the natural state to the greatest degree (Figures 10a and 10b) in regard to load bearing capacity.

**Measuring success**

Stable crestal bone levels are the yardstick by which treatment success and health are measured in the orofacial ecosystem, whether it relates to natural tooth retention or restorative and/or replacement rehabilitation. It is therefore surprising that the treatment outcome standards for
osseo-integration accept crestal bone remodeling and resorption of up to 1.5 - 2mm during the first year following fixture placement and prosthetic insertion 51.

The concept of “biological width” outlines the minimum soft tissue dimension that is physiologically necessary to protect and separate the osseous crest from a healthy gingival margin surrounding teeth and the peri-implant environment.

A bacteria-proof seal, the lack of micro-movement associated with a friction grip interface and a minimally invasive second-stage surgery (where indicated) without any major trauma to the periosteal tissues, are also important factors in preventing cervical bone loss. The literature suggests that the stability of the implant/abutent interface may have an important early role to play in determining crestal bone levels 52.

Tarnow’s seminal study on crestal bone height support for the interdental papilla clearly showed the influence of the bony crest on the presence or absence of papillary between implants and adjacent teeth 53. Twenty years later, logic dictates that anticipated early crestal bone loss and diminished, albeit continual loss, during successive years of function, should have been engineered out of the substitution algorithm for peri-implant tissues 54.

Platform switching: By default or by design
‘There is no logical way to the discovery of elemental laws. There is only the way of intuition, which is helped by a feeling for the order lying behind the appearance,’ Albert Einstein.

Platform switching theorises that by using an abutment diameter of a lesser dimension than the periphery of the implant fixture, horizontal relocation of the implant-abutment connection will reduce remodeling and resorption of crestal bone after insertion and loading.

The concept implies that peri-implant hard tissue stability will engender soft tissue and papilla preservation. Maeda et al reported that stress levels in the cervical bone area peripheral to a fixture were reduced when a narrow diameter abutment was connected in comparison to a size commensurate with the fixture diameter 55.

The authors concluded that the biomechanical advantage of shifting stress concentrations away from the cervical area will diminish their impact on the biological dimension of hard and soft tissue extending apically from the FAI (Fig 11a, 11b and 11c). The inherent disadvantage is that it shifts stress to the abutment screw with the potential for loosening or fracture.

Ericsson et al 56 detected neutrophilic infiltrate in the connective tissue zone contacting the implant-abutment interface. The facility by which platform switching/shifting reduces bone loss around implants has been investigated by Lazzara et al 57. The authors hypothesised, that if the abutment diameter matches that of the implant, the inflammatory cell infiltrate is formed in the connective tissue mimics natural separation of papillae between implants and prevents overhangs.

If an abutment of narrower diameter is connected to wider neck implant, the FAI is shifted away from the outer edge of the implant, thus distancings inflammatory cell infiltrate away from bone. Hypothetically, less crestal bone loss is expected and an increased implant/abutent disparity allows more stable peri-implant soft tissue integration.

Baggi et al conducted a finite element analysis experiment to define stress distribution and magnitude in the crestal area around three commercially available implants – ITI Straumann® (Institut Straumann AG, Basel CH), Nobel Biscare (Nobel Biocare AB, Goteborg SE) and Ankylos CX (Dentsply-Friadent, Mannheim, DE) 58. Numerical models of maxillary and mandibular molar bone segments were generated from computed tomography images and local stress vectors were introduced to allow for the assessment of bone overload risk. Different crestal bone geometries were also modeled.

Type II bone quality was approximated and complete osseous integration was assumed. It was concluded that the Ankylos CX implant based on its platform performance would have the best long-term peri-implant hard tissue stability. Maeda et al reported that stress levels in the cervical bone area peripheral to a fixture were reduced when a narrow diameter abutment was connected in comparison to a size commensurate with the fixture diameter 59.
switched and subcrestally positioned design demonstrated better stress based performance and lower risk of bone overload than the other implant systems evaluated.

Essential features

Platform switching, together with a stable implant-abutment connection are increasingly accepted essential implant design features required to reduce or eliminate early crestal bone loss. A bacteria-proof seal, a lack of micro-movement due to a long friction grip tapered channel and minimally invasive second-stage surgery without any major trauma for the peri-implant tissues are also important factors in preventing cervical bone loss.

A preconfigured platform switched design has a significant impact on the implant treatment in esthetic areas as not only is the tissue biotype preserved, but it has been shown to be enhanced by osteose generation over the collar of the fixture (Figs 12a and 12b)56.

The endodontic implant algorithm parallels the question, which came first, the chicken or the egg as an example of circular cause and consequence. It could be reformulated as follows: ‘Which came first, X that can’t come without Y, or Y that can’t come without X?’ An equivalent situation arises in engineering and science known as circular reference, in which a parameter is required to calculate that parameter itself. This is the essence of foundational dentistry.

Nature wisely created a structure that could harmoniously interoperate hard and soft tissue, act as the portal of nutrition and communication for the body and be the gate-keeper on guard and in function through our lifetime. As such, our role is to ensure that however we reengineer nature, we must adhere to its rules, its logic and fundamentals.

The best evidence

This is not an easy task, as filtering out the best range of evidence from a wide range of sources, presenting clear, comprehensive analyses and incorporating patient experience is a Herculean task. In many ways, this is analogous to Alice’s Adventures in Wonderland as so much of what we do grows ‘curiouser and curiouser’ as each new innovation demands that we go through the looking glass and determine what Alice found there.

References