The Biologic Imperatives of Endodontics and Implantology: Fashioning a Risk Assessment Algorithm

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The functional success rates for endodontically treated teeth are without equal.[1] As it is manifest that a natural tooth is preferable to an unnatural replacement, it is therefore incumbent on the practitioner to be familiar with what is possible in terms of maintaining a natural tooth (Fig. 1). The success rates of primary treatment, retreatment and microsurgical retreatment of non-surgical retreatment are equally as significant as those for implants. Given the disparity between the implant and endodontic re-treatment literature and the lack of data-based results re; indications and contraindications for the use of one or the other, treatment planning is a daunting and complex endeavour.[2] There is a need for a meaningful algorithm to provide the clinician a risk assessment prognosis analysis in treatment planning in order to resolve this conundrum as the lack of standardized outcome evaluations and broadly conceived dimensions of performance makes it difficult to compare the literature accurately.[3,4]

There are those who challenge the continued value of root canal therapy, particularly retreatment, as a viable treatment planning option (Fig. 2). Unfortunately, the success rates for implant therapy, while appearing to be statistically higher than root canal therapy, may have more to do with the protocols and analytic tools used to determine success than with reality. Any comparison must be meaningful, exacting, standardized and direct. Treatment outcome studies from multiple centres must be performed to arrive at reasonable and valid correlations between cumulative survival and functional success rates in both the implant and endodontic modalities.[5,6]

Based on selected follow-up studies, the chance of teeth without apical periodontitis to remain free of disease after initial endodontic treatment or those with apical periodontitis to completely heal after initial treatment or retreatment and the chance of teeth with apical periodontitis to completely heal after apical surgery is a lower percentage than demonstrated for implants; however, the chance for these teeth to be functional over time is 86 percent to 92 percent which places them in the same strata as implants[7] (Fig. 3). The number of outcome predictors becomes literally arcane beyond the aforementioned obvious variables; intra-operative complications, number of roots, treatment technique, periodontal procedures required, ferrule size, et al and yet, all are predictable mainstream procedures.[8-10] Expediency does not obviate their impact on success and thus the creation of a logical treatment planning algorithm becomes all the more relevant (Fig. 4).

The following are the common principles that hold true for debridement and disinfection: 1) instrumentation of the root canal space debrides and morphometrically enlarges the lumen to enable the flow of irrigants and intracanal medicaments into the vagaries of the canal system, albeit with "limited" effectiveness, 2) irrigants effect lysis and dissolution of

FIGURE 1—The biologic imperative of endodontic success is well defined; deep shape to facilitate irrigant penetration, electronic length control to the apical aperture, morphometric shaping, adhesive obturation and coronal sealing are all well documented in the literature as the keys.

pulp tissue, however, they too are limited in terms of penetration by the existence of a definitive negative pressure differential system to ensure they reach the apical aperture and not beyond, 3) intra-canal medicaments are used to finalize the microbial control phase of treatment, however, the effectiveness of any one single material remains in question, 4) the canal space must be obturated with a technique and a material that provides a microstructural replication of the totality of the root canal space and, 5) a coronal seal after treatment is essential so as to ensure that inadvertent exposure of the obturation material to saliva and microflora does not occur and leakage ensue. New file designs, new irrigation modalities and bonded obturation materials provide great promise for the removal of biofilm and the creation of a monobloc impervious seal within the root canal space (Fig. 5).[11-15]

The technical aspects of endodontics have been transcendent for the past decade; however, there is no formula for predictable clinical success. Be it anecdotal, empirical, mechanistic, biological, the presence of pre-existing conditions, diminished adaptive capacity, or the inability to achieve a satisfactory standard for the control and elimination of infection, the healing response to an endodontic procedure is directly linked to the technical quality of root canal treatment. Lower endodontic success rates in cross-sectional studies are due to poor technique.[16] Thus the solution is not replacement of the natural tooth with an implant but the improvement of the endodontic technique to ensure survivability and functional success. The following sequence delineates an optimal approach to definitive endodontic therapy (*courtesy of Fred Barnett*).

1. Correct diagnosis.
2. Well designed access preparation.
3. Location of all the orifices to the root canal system.
4. Obtain and maintain accurate working length (WL) to the apical aperture.
5. Debridement with the understanding that native canals anatomy is not round and that instrumentation of the out of round areas must be addressed.
6. Continuous and deep irrigation with appropriate solutions.
7. Suitable apical enlargement to proper sizes based upon morphology of the root canal space, not the philosophy of 'gurus' in terms of the "look".
8. The placement of a proper antimicrobial disinfectant to assist in dissolving tissues and neutralizing toxins (LPS, TNF, etc.) as well as microorganisms that are left behind in spite of our best efforts — interim medication — two visit protoco.l
9. A proper coronal seal.
10. At the second appointment; re-establish the correct WL.
11. Thorough irrigation, re-establishment of apical patency with a size #08 or #10 hand file.
12. Apically gauge and apically clear the last few mm's of canal space.
13. Final rinses with appropriate solutions in the proper sequence.
14. Use ultrasonics with NaOCl.
15. Remove the smear layer with EDTA, Citric Acid, BioPure MTAD and/or Smear Clear.
16. Use CHX as last irrigant and cone-fit in CHX.
17. Dry the canal and look for exudation.
18. Microstructrurally replicate the canal system.
19. Place a proper coronal seal — composite or GIC.
20. Follow-up the case, assess healing over time.

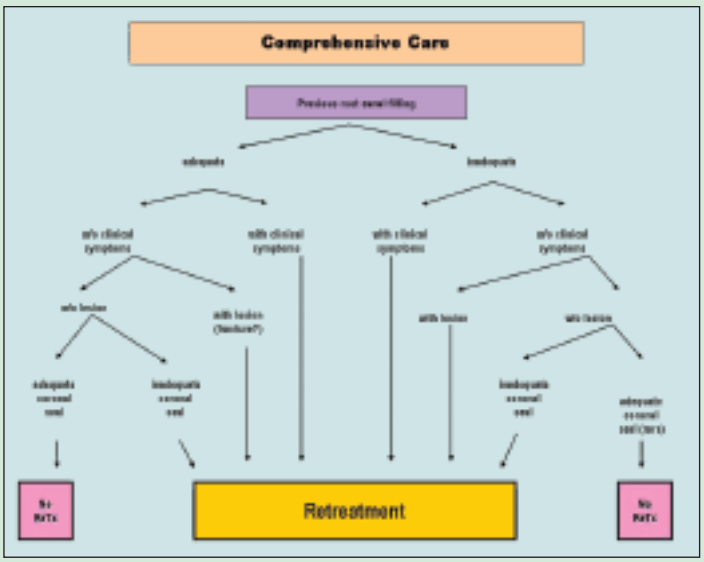

FIGURE 2—The comprehensive care algorithm for preserving the natural tooth in the event of primary treatment failure is a complex one. Fortunately, an armamentarium and knowledge base exists today that facilitates almost all contingencies. *(Courtesy of Arnaldo Castellucci)*

The continued sophistication of osseo-integrated titanium implants over the past four decades and their levels of clinical success provide another dimension to comprehensive and reconstructive dental care when the natural tooth can no longer act as a functional component (Fig. 6). However, the complexity of treatment planning and the sequencing of therapy in implant-assisted and

implant-supported cases are far from a panacea as any surgical procedure, biomimetic or otherwise can hardly be categorized as routine. The clinical and systemic factors affecting the longevity of an implant retained fixture need to be considered as well as location, bone quality and amount, and the condition of the patient's other teeth. Add to this the complexity involved in achieving natural implant aesthetics, bone foundation, implant design and placement, soft-tissue profile, prosthetic tissue support, and ceramic art design and this risk assessment algorithm becomes all the more important.[18]

The main predictors for implant success are the quantity and quality of bone, primary stability, the patient's age, the dentist's experience, the location of the fixture placement, length of the implant, axial loading, and oral hygiene maintenance. Primary predictors of implant failure are poor bone quality, chronic periodontitis, systemic diseases, smoking, unresolved caries or infection, advanced age, short implants, eccentric loading, an inadequate number of implants, parafunctional habits and absence/loss of implant integration with hard and soft tissues as well as inappropriate prosthesis design. All may contribute to implant failure.[19-21]

The implant modality in spite of the expansive success rate claims is nonetheless subjective to investigatory interpretive flux. The criteria for the evaluation of implant success should ideally include lack of pain, mobility, radiolucency, bone loss, infection, or paresthesia, as well as acceptability and stable aesthetics.[22]

FIGURE 3—Endodontic therapy is defined as the elimination of apical periodontitis by optimal debridement and disinfection of the root canal system. Shortcomings in levels of expertise by the operator and technique limitations in regard to microflora dispersal are the predictors of successful outcomes. Biologic reality is unfailingly successful.

FIGURE 4—The patient was referred for retreatment of the failing primary endodontic procedure on tooth #3.7. The reason for the failure however, was not factored into the algorithm for success. Crown lengthening/architectural recontouring to ensure an adequate marginal ferrule width would result in a periodontally unsustainable result and ultimately tooth loss.

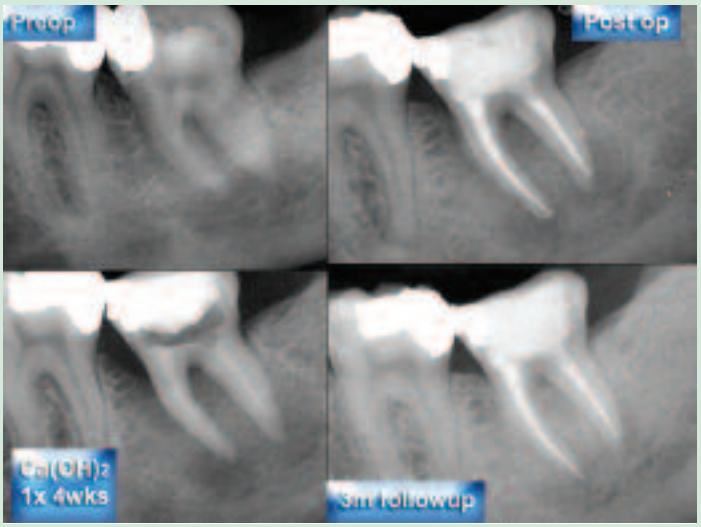

FIGURE 5—Advocacy for the use of interim calcium hydroxide therapy in cases where the pulp is necrotic, chronic apical periodontitis is evident or retreatment is indicated has been shown to substantially increase treatment success rates. Much remains to be learned about biofilm elimination in root canal systems in order for endodontic therapy to truly approach one hundred per cent predictable clinical success. *(Courtesy of Fred Barnett)*

FIGURE 6—The risk assessment algorithm extrapolates to many reconstructive protocols. Tooth #1.5 will require root canal therapy, post/core rehabilitation and full coverage regardless of whether it will be a component of a fixed bridge to replace the missing tooth or simply be reconstructed as the condition of the restoration mandates. Its use as a single functional unit in contrast to the stress impact of a bridge retainer presents a far more positive potential treatment outcome.

Dental implant survival versus success rates must be assessed under a variety of clinical conditions and identifiable prognostic variables such as length, well size, implant coating, sinus lift necessity and timing of implant placement relative to tooth extraction.[23] A recent paper by Dodson[24] showed implant survival rates at one year ranged from 90.3 percent for immediate-load implants to 96.2 percent for implants inserted into grafted sinuses. The five-year survivals ranged from 87.9 percent (sinus graft cases) to 91.2 percent (all implants).

Topographical alteration of the implant surface in order to regulate osteoblastic differentiation has been under investigation ever since improved fixture integration by contrast with machined surfaces was demonstrated. The external surface of implants afford numerous dimensions for multivariate analyses in regard to success and failure parameters; mechanical, topographical and physico-chemical. Biofunctionalization of the implant surface through sandblasting, acid-etching, fluoride inclusion and array of co-polymers will further facilitate bone regeneration and thus implant success rates.[25] In many ways, this is analogous to the monobloc adhesion obturation potential now being advocated in endodontics to prevent microleakage of the root canal system.[26] Both trends will prove to be yet another variable to factor into the risk assessment algorithm.

Endodontics and implant dentistry are in continual experimental states of flux in regard to success predictors and treatment outcome protocols. Any procedure that can be validated by evidence based science should be factored into comprehensive care. Expediency, the ensuent rush to judgment and anecdotal, empirical bias must never replace case selection, treatment planning and ultimately respect for the healing capacity of a biologic organism. When the natural tooth can no longer be treated within predictable parameters, then the biomimetic option should be presented, taking into account all variables that impact upon its success rate. Therefore, the choice in the author's opinion is not between implants and endodontics as it is now portrayed, but between what is restorable and saveable periodontally vs implant replacement as an algorithm of functional success. The true decision is not between endodontics and implants, but greater accuracy in diagnosis of fractures of endodontically treated teeth, the success of crown lengthening procedures, and the success of periodontal therapy in regard to marginal periodontitis.

A risk assessment algorithm is one of many tools that will optimize predictable clinical success. In order for the practitioner to successfully integrate any new treatment approach, it must represent inclusion of the new, however, not at the expense of exclusion of the traditional. Fundamentals and rudiments are the basis of all art and science. As such, endodontics and implantology must acknowledge and ultimately embrace the strengths each brings to the equation that creates dental health. As Shelley wrote many years ago, "Man's yesterday may ne'er be like his morrow; Nought may endure but mutability." **OH**

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Oral Health welcomes this original article.

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