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Back to the Egg; Part II
Kenneth Serota continues his look at the Endodontic Implant Algorithm

Dentin is the most abundant mineralised tissue in the human tooth. In spite of this, it has been a focus of research for over a century of research has failed to provide consistent values of dentin’s mechanical properties. In clinical dentistry, knowledge of these properties is pivotal to any number of variables ranging from innovations in preparation design to the choice of bonding materials and methods.

The Young’s modulus (the measure of the stiffness of an isotropic elastic material) and the shear modulus (modulus of rigidity) are diminished by visco-elastic behaviour (time-dependent stress relaxation) at strain rates of physiologic (functional) relevance. The reported tensile strength data suggests that failure initiates at flaws. These flaws may be intrinsic, perhaps regions of altered mineralisation, or extrinsic, caused by cavity or post channel preparation, wear, or damage. There have been few studies of fracture toughness or fatigue (1). Finally, little is known about the biomechanical properties of altered forms of dentin subsequent to decay, the influence of irrigants, chemicals and the choice of curing techniques used for bonded restorations (2).

Studies suggest that there are at least two forms of transparent or sclerotic dentin; a form associated with caries and a form associated with age-related changes in the root. The impact upon tooth strength as a function of these altered forms of dentin is not well understood.

The long-term predictability of residual coronal tooth structure to function in a manner commensurate with the demands of the orofacial ecosystem, may need to be reassessed in light of observations that sclerotic dentin, unlike normal dentin, exhibits no yielding behaviour before failure and that the fatigue lifetime is deleteriously affected at high stress levels (3). Mechanisms for energy dissipation and crack growth resistance present in young dentin are not present in old dentin. Restorative methods and techniques, particularly as it relates to ferrule creation for endodontically treated teeth, may need to be amplified to address the fact that fatigue crack growth resistance of dentin decreases with age (4).

‘There are primary causes that predispose teeth to fracture and secondary causes that predispose fracture after a period of time’

Addressing clinical problems
Understanding the mechanical properties of teeth is essential in order to address the most common clinical problem affecting all endodontically treated teeth, fracturing, which in spite of even minimal loss of tooth structure may be severe enough to necessitate removal (5). The hypothesis that dentin brittleness increases with diminished moisture content has been debunked; conserving bulk dentin is the sine qua non of fracture prevention.

Kutler et al reported that dentin thickness correlates inversely to post space diameter in the distal roots of mandibular molars (6). A #4 Gates-Glidden drill caused strip perforations in 7.5 per cent of canals studied. The authors recommend that Gates-Glidden drills no larger than a size #5 be used. After endodontic treatment, the forcuton side dentin thickness was less than 1mm in 82 per cent of the distal roots studied (Fig 4).

There are primary causes that predispose teeth to fracture and secondary causes that predispose fracture after a period of time (Fig 5). Endodontics is a component of an interdisciplinary process and a chain is only as strong as its weakest link.

Subsequent to any endodontic procedure, intensity of stress concentration and tensile stresses within an endodontically treated tooth will depend upon (5) the material properties of the crown, post, and core material chosen, (6) the shape of the post, (7) the adhesive strength at the crown-tooth, core-tooth, and core-post, post-tooth interfaces, (8) the magnitude and direction of occlusal loads, (9) the amount of available tooth structure and (10) the anatomy of the tooth. Any combination of vector stress concentration and high tensile stresses will predispose these teeth to fracture without an adequately engineered restorative design.

Reengineering
Reengineering negative treatment outcomes is a significant part of the contemporary endodontic oeuvre. The presence of apical periodontitis may or may not affect the outcome of initial endodontic treatment (10). However, there is a general consensus that apical periodontitis...
Apical surgical “correction” of intracanal infections may isolate, but not eliminate, the residual microflora of the root canal space. It should therefore be limited to situations where non-surgical retreatment is judged impractical.

With the range of sophisticated equipment and material in the conventional endodontic armamentarium, this is a remote consideration at best. When the etiology is independent of the root canal system, surgery is the most beneficial treatment (28). Non-surgical retreatment may still be indicated in these cases, especially when intracanal infection cannot be ruled out. Time constraints or financial pressures, should never be a factor in making surgery the first treatment choice (Fig 7).

Other options
The variables associated with non-surgical retreatment are myriad and treatment outcome studies in endodontics have been egregiously abused by those wishing to diminish the value of re-engineering natural teeth. Many studies have categorised teeth with caries, fractures, peri-apical involvement and poor coronal restorations as negative substrates and bio-corrosion of metallic substrates and bio-corrosion of metallic irritants and medicaments on dentin, the effects of bacterial interaction with dentin substrate and bio-exposure of metallic post-covers.

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**Unoccluded dentine**

**After treatment and a 30 second acid challenge**

**After treatment and a 10 minute acid challenge**

In vitro study of dentinal tubule patency following an acid challenge (immersion in grapefruit juice, pH 3.3) applied after dabbing and massaging for one minute with Sensodyne Rapid Relief. Adapted from4.

Recommend Sensodyne Rapid Relief for rapid relief from the pain of dentine hypersensitivity

* when directly applied with finger tip for one minute  ** when used twice daily

References:

“Give me something that works fast and I might be interested”

Patient, UK

Fig. 4. A) Less porous, less hydrated and highly mineralised outer dentine. B) Pulp canal space. C) More porous, more hydrated and less mineralised inner dentin.

Fig. 5. Primary causes of fracture include excessive structure loss, loss of free unobstructed water from the root canal lumen and dentinal tubuli, age induced changes in the dentin and restorations and restorative procedures. Secondary causes of fracture include the effects of endodontic irrigants and medicaments on dentin, the effects of bacterial interaction with dentin substrate and bio-exposure of metallic post-covers.
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About the author
Kenneth S Serota, DDS, MSc graduated from the University of Toronto, Faculty of Dentistry in 1975 and was awarded the Henry W. Sittner Memorial Key for excellence in professional dentistry. He received his Certificate in Endodontics and Master of Medical Sciences Degree from the Harvard-Forsyth Dental Center in Boston, MA. A former assistant in the Endodontics Division of the Department of Oral Biology, Boston University School of Dental Medicine, he is on the editorial board of Endod Pract and Endod Case Reports. He has authored over sixty publications, including two books. Dr Serota is a fellow of the American and Canadian Academies of Endodontics and is a diplomate of the American Board of Endodontology. He is a past editor of Endod Treatment; is on the editorial boards of the Journal of Endodontics; the Indian Journal of Endodontics; and is a former associate editor of the International Endodontics Journal.