Endodontics—Does the biology matter?

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Fig. 1a


Fig. 1b

Figs. 1a & b_An example of technically high-quality endodontics in which biological imperatives have not been met: despite the location and preparation of the second root canal and the well-condensed obturation of the root-canal system to length, the lesion associated with the tooth has increased in size.

_Root-canal treatment is the most technically demanding procedure in dentistry. In order to prepare and obturate successfully the labyrinthine root-canal systems that we are faced with on a daily basis, relying purely on tactile sensation, takes great skill, developed over many years to even come close to mastery of the art. Since the technical difficulties are considerable, it is perhaps understandable that great pride can be taken in the production of an aesthetically pleasing post-operative radiograph. Equally understandable perhaps, if we judge the success of our procedure this way, is that much of the teaching and practice of endodontics focuses on the technical skills required to achieve good results. Does it matter then that we are treating a disease? In order to achieve good outcomes, do we really need to understand the disease we are treating, or simply be proficient at preparing and obturating canals?

Apical periodontitis is the disease that, as endodontists, we spend most of our practising lives treating. Some would argue that a thorough understanding of the aetiology, pathogenesis and microbiology of the disease should be a prerequisite to successful treatment, and essential knowledge for any student or practitioner of endodontics. It is, however, quite often the case that those undertaking root-canal treatment simply view the procedure as a technical exercise—a series of steps that must be undertaken in order to obtain the desired obturation radiograph. If the success of this approach, in terms of healing, is equivalent to that reported in contemporary literature, then can it be argued that a biological approach to root-canal treatment is not necessary.

These issues were amongst those discussed by Prof Kishor Gulabivala in his keynote lecture to the European Society of Endodontology Congress in Edinburgh last year. As one of the leading researchers and teachers in the field of endodontics, Prof Gulabivala was able to address the subject from several angles. Firstly, he presented a synthesis of the existing literature on the aetiology and pathogenesis of apical periodontitis, and thereafter an examination of several of the microbiological aspects of the disease. Next, he discussed the manner in which clinical intervention influences the disease process. Lastly, he presented a number of conclusions based on his personal insight, along with a discussion on

the disconnect that exists between the biological and technical aspects of endodontic training.

The microbial aetiology for apical periodontitis is well established. Classic work by Kakehashi *et al.*,[1] Sundqvist[2] and Moller *et al.*,[3,4] amongst others, demonstrated the causal relationship between the presence of bacteria in the root canal and the development of apical periodontitis. The continued development of the disease appears dependent on the interaction between the host response and the root-canal microbiota; changes in either will have an effect on its progression. As microbial identification methods become increasingly sophisticated, it will hopefully be possible to identify more of the bacterial species present in what is a hugely diverse infection. It is also important to explore and identify those species associated with disease progression, clinical symptoms, treatment resistance and treatment failure. Identification methods that are more complex will be required, as even variations at subspecies strain level can complicate the situation and influence the development of apical periodontitis.

Whilst identification of the microbiota will give insight into the development of the disease and its associated symptoms, this is only part of the picture. The biofilm concept is now well recognised in endodontics; this means that in addition to identifying species present within an endodontic infection, it is also important to understand the way they may interact and communicate with other, whether the interaction is synergistic or antagonistic, the way nutritional needs are met and the way the biofilm community organises itself for optimum efficiency. Future treatment strategies need to be informed by research conducted into endodontic biofilms; unfortunately much current practice has been developed based on what now appears to be an outdated infection model.

So, having discussed where we are with our knowledge of the microbiology and aetio-pathogenesis of apical periodontitis, the original question still stands. Does a greater understanding of the biology of the disease by those who treat it offer a better chance of enhanced outcomes, and if so how?

Having established a putative disease and microbial model for apical periodontitis, we need to look at our treatment protocols to determine whether they are appropriate for the problems the science has identified. Whilst the technical aspects and difficulties of root-canal treatment cannot be ignored, they need to be considered in conjunction with the biological imperatives, namely reducing the infection within the root-canal system down to a level at which the balance between disease progression and repair is tipped in favour of repair. The highly complex nature of the root-canal system, and the widespread and diverse nature of the infection within it, makes it unlikely that complete disinfection can take place. A study by Nair *et al.*[5] demonstrated that even in well-treated teeth biofilm


Fig. 2a


Fig. 2b

Figs. 2a & b_When high quality technical work is combined with a biological approach to treatment, healing is likely. A substantial reduction in the size of this lesion, over a nine-month period, occurred as a result of good isolation, thorough chemo-mechanical canal preparation, incorporating active irrigation, and then well-condensed obturation to the apical terminus.

remains, particularly in the apical portion of the root. This may explain why endodontic success rates have not improved greatly in over a century. Existing treatment protocols, with their technical bias do not address these problems effectively.

The fundamentals of treatment have not changed in many years: remove as much of the necrotic and infected material from the root-canal system as is possible, and obturate the root-canal system in its entirety to prevent bacterial recontamination and to incarcerate residual bacteria, without extrusion beyond the apical terminus. Our understanding of the nature of the root-canal infection may be developing, but unless this is followed by development of treatment strategies, which are based on this new knowledge, then treatment outcomes are unlikely to improve. One highly desirable development would be the ability to identify bacteria persisting in the root canal with a simple chairside test. Culture testing was once a common part of endodontic treatment; as molecular testing improves, hopefully it can be introduced into the clinical environment to better inform the clinician of his treatment options.

Chemical disinfection plays a large part in the overall preparation phase of root-canal treatment, yet its importance is overlooked by a large number of practitioners, who instead look to the continually evolving file systems with which canals are prepared to improve their treatment. Whilst these file systems may make treatment more efficient, do they make it more efficacious? Only if the time saved in the shaping of the root canal is then devoted to its thorough disinfection, generally by chemical means.

The study of irrigation dynamics and the chemistry of existing and novel irrigants has only recently come under the spotlight. This area of research may give us insight into the way to better to disrupt and deactivate root-canal biofilms and in doing so improve our outcomes.

For the research to be relevant, robust experimental models must be developed that closely approximate to the clinical environment. It is an area that has been the subject of much study at the Eastman Dental Institute, with a number of papers recently published in the endodontic literature.

So, do we have the answer to our question? Success rates for endodontics, as evidenced by contemporary literature have stayed largely constant over the last century. Treatment objectives have remained similar within that period. If we are to improve our outcomes, then we need to let the science better inform our treatment procedures.

To summarise where science has brought us, we can return to the conclusions drawn by Prof Gulabivala at the end of his ESE lecture:

_The nature of intra-radicular infection is complex in its diversity and biological interactions within it and with the host.
_The nature of the infection and the host's reaction to it probably dictate the nature of clinical and radiographic presentation.
_The nature of infection strongly influences the clinician's efforts to control it, and therefore the outcome.
_The clinical presentation may provide a strong clue to the probable outcome of contemporary root-canal treatment.
_The link between the technical aspects of contemporary root-canal treatment and biological events is non-specific at best.
_Improvement of treatment success will require a better understanding of the nature of infection and ways to control it apically.

The answer then is yes; the biology does matter._

_about the authors

roots

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