IN BRIEF

- Root canal treatment is normally prescribed to treat an infection, and as with all surgical procedures an aseptic technique is essential throughout.
- As research has shown that success is only achieved when all microorganisms are removed from the entire root canal system, the anatomy of this system must be understood for each tooth.
- Modern endodontic practice is concerned not with the old cliché of *cleaning*, *shaping* and *filling*, but with *shaping* first, to open the canals wide, so that *cleaning* can be effectively carried out prior to three-dimensional *filling*.

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Endodontics: Part 1
The modern concept of root canal treatment

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Root canal treatment has changed considerably since the hollow tube theory was first postulated in 1930. Research continues into the elaborate anatomy of root canal systems, and also into the microbial causes of endodontically related diseases. Only by understanding these aspects in detail can the practitioner quickly and effectively *shape* the main root canals to facilitate thorough *cleaning* of the entire system, and easy and effective *filling*.

ENDODONTICS

1. **The modern concept of root canal treatment**
2. Diagnosis and treatment planning
3. Treatment of endodontic emergencies
4. Morphology of the root canal system
5. Basic instruments and materials for root canal treatment
6. Rubber dam and access cavities
7. Preparing the root canal
8. Filling the root canal system
9. Calcium hydroxide, root resorption, endo–perio lesions
10. Endodontic treatment for children
11. Surgical endodontics
12. Endodontic problems

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In 1965 Kakehashi, Stanley and Fitzgerald[1] showed conclusively that pulpal and endodontic problems are primarily related to microbial contamination of the root canal system. Since that time endodontology has increasingly focussed on the ways and means of eliminating microorganisms from the entire root canal system.

The majority of patients who require root canal treatment will have been diagnosed as suffering from the disease of periradicular periodontitis. The treatment of this disease must address the microbial contamination of the entire root canal system. It must also be carried out under aseptic conditions in order to prevent further microbial ingress, in particular from saliva. The use of a rubber dam very much reflects the use of a surgical drape in other invasive medical procedures. Such a biological approach will be emphasized throughout this text. The temptation to regard root canal treatment as a purely mechanical procedure, producing excellent post-operative radiographs but with little regard to diagnosis and prognosis, must be resisted in today's practice.

Research into the morphology of the pulp has shown the wide variety of shapes, and the occurrence of two or even three canals in a single root.[2] There is a high incidence of fins which run longitudinally within the wall of the canal and a network of communications between canals lying within the same root (Fig. 1). The many nooks and crannies within the root canal system make it impossible for any known technique, either chemical or mechanical, to render it totally sterile. The objective of treatment must be to reduce the level of microbial contamination as far as is practical, and to entomb any remaining microorganisms with an effective three-dimensional seal.

The prime aim when preparing the root canal has long been stated as *cleaning and shaping*. One of the prime aims of this text will be to encourage the practitioner to see this in reverse, ie *shaping and cleaning*. Modern instruments and techniques will be described which rapidly open and shape the main root

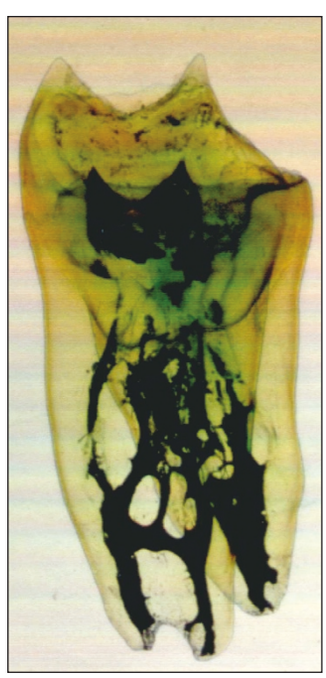

Fig. 1 The root canal system of this lower molar has been stained and the tooth totally decalcified, showing the complex nature of the root canal system. (Courtesy of Professor R T Walker.)

Fig. 2 (a) The pre-operative radiograph of tooth LR6 (46) shows a large radiolucent area associated with the root apex and the furcation area. Root canal treatment was commenced. (b) A radiograph 6 months later when the patient finally returned to continue treatment shows evidence of bony repair with a return to a normal periodontal ligament space around the apex and in the furcation.

canals, thus permitting the effective access of antimicrobial irrigants to the entire root canal system, including lateral canals, fins, anastamoses and other canal aberrations. It is imperative that these instruments are not seen as providing a route to quick and speedy root canal treatment. To achieve success the time saved by the rapid opening of the canal system must be spent in thorough and effective antimicrobial irrigation.

Research has also shown that when an infected root canal is accessed, the number of different species of microorganisms is small, rarely above single figures.[3] Treatment will become far more difficult and extended, and success may well be compromised, if this flora is altered by the ingress of saliva. Isolation of the tooth under treatment is essential not only for medicolegal reasons to protect the airway, but, far more importantly, to prevent further contamination of the root canal system and to permit the use of strong intracanal medicaments.

Other areas of research have had the significant effect of changing the approach to endodontic treatment. The hollow tube theory put forward by Rickert and Dixon in 1931[4] postulated that tissue fluids entering the root canal stagnated and formed toxic breakdown products which then passed out into the periapical tissues. This theory, that dead spaces within the body must be obturated, originally formed the basis for filling root canals. However, a variety of different studies have demonstrated that, on the contrary, hollow tubes are tolerated by the body. As a result there are currently two indications for filling a root canal, once the canal system has been shaped and cleaned. Firstly, to prevent the entry of microorganisms to the root canal system from either the oral cavity, should the coronal restoration leak or fail, or via the bloodstream (anachoresis). Secondly, to prevent the ingress of tissue fluid which would provide a culture medium for any bacteria remaining within the tooth following treatment.

A report by Klevant and Eggink[5] is particularly relevant. They shaped and cleaned a number of root canals, but the experimental group were not obturated. They ensured that an effective, well-sealed, coronal restoration was placed. They found that healing occurred in every case. Figure 2 shows a lower molar with a large periradicular lesion. The root canal system was shaped and cleaned, and an intervisit dressing of calcium hydroxide placed. The patient did not return for further treatment for 6 months, when a radiograph revealed that complete healing had taken place.

Of course, this does not mean that obturation is unimportant. It is essential for the reasons described earlier. It does prove, however, the old cliché that it is what is removed from the canal that is important, not what is put in. Similarly, Ray and Trope[6] found that root-treated teeth with a poor obturation on radiograph but a good coronal restoration had a better prognosis than teeth with a good obturation but a poor restoration.

The majority of root canal sealers are soluble and their only function is to fill the minute spaces between the wall of the root canal and the root filling material. Their importance, judged by the number of products advertised in the dental press, has been over-emphasized. Despite much research, gutta-percha remains the root filling of choice, although it is recognized that a biologically inert, insoluble and injectable paste may be better suited for obturation of the root canal. Most of the new root canal filling techniques are concerned with methods of heating gutta-percha, making it softer and easier to adapt to the irregular shape of the canal wall. It must be emphasized, however, that, whatever the obturation system used, if the root canal system has not been adequately cleaned healing may not occur (Fig. 3).

Finally, lesions of endodontic origin which appear radiographically as areas of radiolucency around the apices or lateral aspects of the roots of teeth are, in the majority of cases, sterile.[7,8] The lesions are the result of toxins produced by microorganisms lying within the root canal system. This finding suggests that the removal of microorganisms from the root canal followed by root filling is the first treatment of choice, and

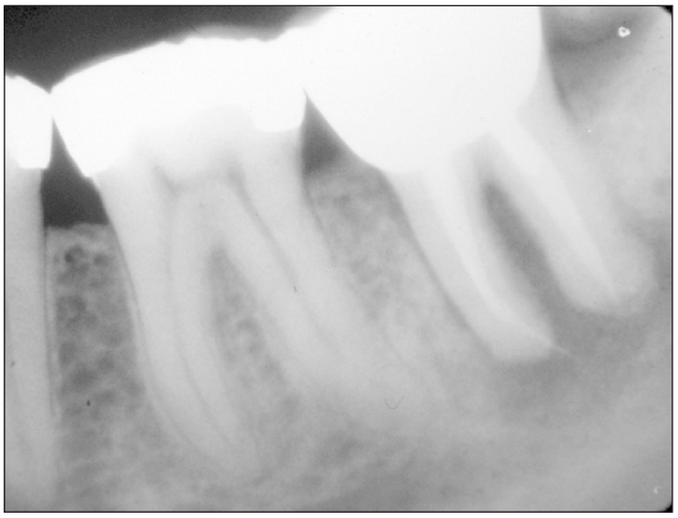

Fig. 3 A radiograph of tooth LL7 (37) showing a root canal treatment carried out 12 months previously, with what appears to be an effective obturation yet no evidence of healing of the periradicular lesion.

that periradicular surgery, including an apicectomy with a retrograde filling, can only be second best.[9] Apicectomy with a retrograde filling at the apex is carried out in the hope of merely incarcerating microorganisms within the tooth, but does not take into account the fact that approximately 50% of teeth have at least one lateral canal. The long-term success rate of apicectomy must inevitably be lower than orthograde root treatment.

In summary, the principles of treatment of the disease of periapical periodontitis are as follows.

Shape: Produce a gradual smooth taper in the root canal with its widest part coronally and the narrowest part at the apical constriction, which, as discussed in Part 4, is normally about 1 mm short of the apex.

Clean: Use antimicrobial agents to remove microorganisms and pulpal debris from the entire root canal system.

Fill: Obturate the canal system with an inert, insoluble filling material.

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