Recent Advances in Endodontics

Dr Robert PY Ng

Assistant Professor, Faculty of Dentistry, The University of Hong Kong

Introduction

Endodontics is the branch of dentistry concerned with the aetiology, prevention, diagnosis and treatment of diseases and injuries that affect the dental pulp, tooth root and periradicular tissues.¹ At the beginning of the last century, focal infection theory had severely threatened the existence of the discipline. Since then, the issue of focal infection has reappeared and become a concern in dentistry, but a definite causal effect has not been shown.² In recent years, advances have been made in various aspects of endodontics, from diagnosis to treatment. This has been made possible mainly by a better understanding of the pathophysiology of the pulp and periradicular tissues and the emergence of new technologies.

Diagnosis of Pulpal/Periradicular Diseases

Diagnosis of pulp and periradicular diseases has been made difficult due to the inaccessibility of the diseased tissues for direct inspection. Indirect signs, such as radiographic findings, presence of pain and swelling, have been used to aid in the diagnostic process. However, it has been shown that the correlation between pulpal inflammation and pain is poor³ and the radiograph is not a very sensitive tool in detecting minor changes in the periradicular tissues.⁴ The various methods of testing pulp sensibility each have their own drawbacks.

It has been suggested that by sampling pulpal fluids to detect certain inflammatory markers, the pulpal status could be determined more accurately.⁵ Hopefully, this would differentiate between reversible and irreversible pulpitis and thereby allowing the selection of the correct treatment modality either to preserve or to extirpate the inflamed pulp. It is important, especially in cases of trauma, to determine whether the dental pulp has retained its blood supply. Traditionally, this has been inferred by testing the sensibility of the dental pulp but errors could occur. With the advent of laser Doppler flowmetry (LDF), the blood supply in a tooth could be assessed and its vitality determined accurately. Due to a possible loss of nerve supply in traumatised teeth, LDF is useful as a tool to monitor the vitality and recovery of such teeth from trauma.⁶

Prevention of Pulpal Diseases

Although caries and restorative procedures could cause pulpal inflammation, the predominant cause of pulpal inflammation is microbial microleakage.⁷ Much effort has been used to improve the properties of dental materials in order to control microleakage. These improved materials are used to reduce the gap at the restoration-cavity wall interface or to coat exposed dentine surface. However, during function, a tooth would deform, the physical barrier formed by these materials would break down as they could not deform to the same degree as the tooth. Until this stumbling block is overcome, it is unlikely that any dental materials could achieve a total and permanent seal against microleakage. From a biological perspective, adherence of bacteria to exposed tooth surfaces is a prerequisite to establishment of bacterial colonies and biofilms leading to subsequent microleakage. It is likely that research into preventing bacterial adherence onto tooth surfaces would provide the answer to microbial microleakage.

Treatment of Exposed Pulp

The outcome of direct pulp capping depends on the presence of a healthy pulp, asepsis as well as the absence of microbial microleakage. Traditionally, calcium hydroxide had been the material of choice as a direct pulp capping agent. Recently, adhesive materials have been suggested as a replacement for calcium hydroxide, but the reported results have been equivocal.⁸⁹ A recently introduced material - mineral trioxide aggregate (MTA), has been shown to be highly biocompatible.⁰ MTA is capable of stimulating dentine bridge formation adjacent to the exposed dental pulp. Direct pulp capping with MTA has been reported to result in less inflammation, hyperaemia, necrosis and thicker dentinal bridges and more frequent odontoblastic layer formation with MTA than calcium hydroxide. Apart from direct pulp capping, MTA is also suitable for repair of root perforation, obturation of incompletely formed roots and as a root end filling material.¹¹

Root Canal Treatment

The process of root canal treatment aims to remove microorganisms, organic and inorganic debris from the root canal system by mechanical instrumentation with files and chemical disinfection with irrigating solutions and intra-canal medicaments. Given the complexity of the root canals, preparation of the root canals is fraught with difficulties and iatrogenic problems are not uncommon.

One of the common obstacles faced by the operator in root canal treatment is the location of the root canals. In teeth...
with large deposits of reparative dentine and sclerotic canals, location of the root canal orifices could be problematic. Naturally, a thorough knowledge of root canal anatomy and fine tactile sense are essential. However, with the help of good magnification and illumination provided by an operating microscope, in experienced hands, location of root canals could be made easier.\(^1\) In addition, using a microscope, with the help of a suitable dye, minute crack lines could be more easily identified.\(^2\)

Apart from helping to locate canals, an operating microscope (or some other form of magnification) is invaluable in endodontic retreatment.\(^2\) With its enhanced vision and lighting, an operator could carry out various procedures, such as bypassing or removing separated instruments, negotiation of ledged canals, repair of root canal perforations and placement of materials such as MTA, more efficiently.

A new breed of endodontic files, made from a nickel-titanium (Ni-Ti) alloy, has been introduced. The Ni-Ti alloy has the desirable property of superelasticity, which makes endodontic files made of this alloy very flexible. These files are able to prepare curved canals concentrically and reduce the incidence of iatrogenic errors\(^1\), with comparable ability to remove intra-canal bacteria as stainless steel hand files.\(^4\) Furthermore, because of its flexibility, the files could be manufactured with an increased taper and potentially could enable the operator to complete root canal preparation with less time and effort.

In an ideal world, in order to preserve the maximal amount of tooth substance after endodontic therapy, its root canals should not be mechanically prepared but cleaned thoroughly with irrigants. A group of researchers in Switzerland has pioneered a method called the Non-instrumentation Technique, using a partial vacuum system to deliver the irrigant into the root canal system.\(^15\) This could be a potentially useful system but at present, is still regarded as experimental.

Various alternative methods to enhance disinfection of root canals have been introduced recently. Photo-activated disinfection (PAD) is a process whereby microorganisms are sensitised by a photactive agent, tolonium chloride. When the agent is stimulated by a light of an appropriate wavelength, radicals are released and bacteria are ruptured.\(^16\) Ozone gas is a powerful oxidative agent and is potently bactericidal.\(^17\) For endodontic purposes, it has been suggested that ozonated oil should be used instead, although there has been no reports on its efficacy.

Surgical endodontics

When a patient does not wish to undergo non-surgical endodontic retreatment or when the procedure is not indicated, then surgical endodontics should be considered in order to preserve the tooth.

The use of an operating microscope and miniaturised ultrasonic tips and hand instruments has revolutionised surgical endodontics.\(^2\) An operating microscope provides co-axial lighting and a range of magnification from \(x\) 5 to \(x\) 30. This will enable the operator to examine the apical region of a root for crack lines and the resected root end for presence of any accessory anatomical features such as fins or isthmuses between root canals.\(^2\)

Using specially designed miniaturised ultrasonic tips to prepare the root end cavities enables the operator to perform root resection at approximately right angle to the long axis of the root, as opposed to a forty-five degrees root resection in earlier days.\(^2\) Some of the advantages of this modern approach are minimising the risk of iatrogenic errors, reducing the number of exposed dentinal tubules and preservation of root dentine.

MTA was originally tested as a root end filling material before its wider applications in endodontics, such as direct pulp capping, were recognised. MTA has been shown to promote deposition of cementum on its surface and to be perfectly compatible with the periapical tissues.\(^17\) Compared to other root end filling materials with a longer history of use, such as amalgam, RM or Super EBA cement, little or no inflammatory cells could be detected in the vicinity of MTA but the same cells would be present around the older materials in greater quantity.\(^2\) However, the handling properties of MTA are not as user friendly as the other materials and its use would require some practice.

Conclusion

There have been advances in all aspects of endodontics, which allow the operator to provide high quality endodontic treatment. Regardless of whether the treatment is preservation of the exposed pulp, first time root canal treatment, root canal retreatment or surgical endodontics, the key to success is still the attainment of sterility within the root canal system.\(^2\) Unless this is achieved, endodontic treatment is likely to fail, despite all the new equipment and technology at our disposal. Moreover, it is interesting to note that the success rates of first time root canal treatment and root canal retreatment reported in the literature have not changed significantly since the second half of the last century.\(^7\)
References


