Quintessentials
口腔临床要点快速掌握系列

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5

实用根管治疗学

Rational Root Canal Treatment in Practice

▶ John M Whitworth [编 著]

▶ 吕红兵 闫福华 [主 译]

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人民軍醫出版社

PEOPLE'S MILITARY MEDICAL PRESS

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Rational Root Canal Treatment in Practice

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人民軍醫出版社
PEOPLE'S MILITARY MEDICAL PRESS
北　京

图书在版编目（CIP）数据

实用根管治疗学／（英）威特沃思（Whitworth）著；吕红兵、闫福华主译．
－北京：人民军医出版社，2006.9
（口腔临床要点快速掌握系列）
ISBN 7-80194-983-8

Ⅰ．实…　Ⅱ．①威…②吕…③闫…　Ⅲ．牙髓病－治疗学－汉、英
Ⅳ．R781.330.5

中国版本图书馆 CIP 数据核字（2005）第 108952 号

策划编辑：杨　淮　**文字编辑**：林　菲　**责任审读**：黄栩兵
出 版 人：齐学进
出版发行：人民军医出版社　　**经　销**：新华书店
通信地址：北京市 100036 信箱 188 分箱　**邮　编**：100036
电话：（010）66882586（发行部）、51927290（总编室）
传真：（010）68222916（发行部）、66882583（办公室）
网址：www.pmmp.com.cn

印刷：北京印刷一厂　　**装订**：春园装订厂
开本：889mm × 1194mm　1/32
印张：5.875　**字数**：219 千字
版、印次：2006 年 9 月第 1 版第 1 次印刷
印数：0001～3500
定价：68.00 元

内容提要

"口腔临床要点快速掌握系列"，是由国际著名的Quintessence出版集团近期出版的一套介绍口腔各科基本技术和最新理论的口腔专业丛书。丛书从2002年起陆续出版发行，我社第一时间引进翻译出版，以便国内读者同步了解国际口腔技术发展的新情况。本书由国际知名口腔专家编著，摆脱了一般专著照本宣科式编写模式，一切从临床实践出发，通过大量实例，讲解了根管治疗的最新理论和最基本、最重要、最实用的操作技术。本书采用中英文对照的编排方式，对提高读者的专业英语水平大有裨益，本书适合临床口腔医师和口腔医学生的阅读。

责任编辑　杨　淮　林　菲

序

牙髓病学是一门发展迅速的临床学科，新器械、新材料和新技术的不断出现推动了该学科的持续发展。对口腔专家而言，及时了解众多的新方法，并将其很好地应用于临床尚有很大困难，这就更不用说工作繁忙的普通口腔医师了。精萃集团出版的《实用根管治疗学》就是为解决牙髓病治疗过程中的这些困难而编写的。本书从解剖学的角度详细地介绍了从根管治疗到提高远期疗效这个过程中牙髓病学治疗的难点。《实用根管治疗学》是精萃集团出版的针对普通口腔医师系列丛书中一本很有价值的分册，有助于口腔医师和学生更新知识。

主　编　**Nairn H F Wilson**

目 录

第1章 牙髓病学基础

Fundamentals of Endodontic Disease

目 的

描述牙髓病和根尖周病的临床生物学基础，为合理的牙髓治疗奠定基础。

要 点

通过学习本章，应该对细菌感染在牙髓病及根尖周疾病中的作用有清晰的认识，并以此指导临床根管治疗的每一步操作。

牙髓病学简介

牙髓病学是临床口腔医学的分支学科，涉及到牙髓病及其并发症的预防、诊断和治疗。其内容广泛，包括以下治疗措施：

- 保存全部或部分健康的牙髓（盖髓术和牙髓切断术）。
- 保存和修复已发生不可复性牙

Aim

To describe the fundamental clinical biology of pulp and periapical disease, and lay the foundations for rationally based endodontic treatment.

Outcome

After studying this chapter, the reader should have clear understanding of the role of microbial infection in pulp and periapical disease, and the need for this knowledge to translate into action at each stage of clinical root canal treatment.

An Introduction to Endodontics

Endodontics is the branch of clinical dentistry concerned with the prevention, diagnosis and treatment of diseases of the dental pulp and their sequela. The discipline therefore has a broad scope, encompassing procedures which aim to:

- preserve all or part of the pulp in health (pulp capping and pulpotomy)
- preserve and restore teeth with irre-

髓炎和牙髓坏死的牙齿(牙髓摘除术和根管治疗术)。

- 保存和修复根管治疗失败或在治疗中受损的牙齿(牙髓再治疗术和根管外科手术)。

在实践中，"牙髓治疗"通常就是指"牙髓摘除术和根管治疗术"，这是一项准确性高、技术性强且发展迅速的临床操作技术，主要强调根管充填的形态和长度，以及满意的X线片充填效果。本书主要讲述成人的根管治疗，并为临床上安全选用各种适合的治疗方法提供理论框架。

根管治疗的技术关键

牙髓病学技术发展日新月异。为了使临床治疗更加简便、快捷，预后更加良好，或为了获得更佳的美学效果，新的治疗系统、设备和材料不断涌现。多年来人们不断地将巨大的人力物力投入于这方面的研究，并取得了丰硕的成果。同样，我们也都经历过满心期待但很快化为泡影的沮丧(图1-1)；每次失败后，所研发的昂贵的系统被束之高阁，同时我们转而采用原有的老方法，或者继续进行新的尝试。

versibly inflamed and necrotic pulps (pulpectomy and root canal treatment)

- preserve and restore teeth with lesions which have failed to respond to root canal treatment, or which were damaged in the course of such treatment (endodontic retreatment and surgery).

In reality, "endodontic treatment" is usually synonymous with "pulpectomy and root canal treatment", an exacting, technical and rapidly developing element of everyday practice, with its emphasis on line, length, and the attainment of a radiographically pleasing root filling. This book will focus almost exclusively on adult root canal treatment and provide a rational framework for the appraisal and safe application of established and emerging clinical methods.

The Technological Focus of Root Canal Treatment

Endodontics has never been shy of technology. New systems, devices and materials appear frequently, promising simpler, quicker, more consistent or aesthetically satisfying results. Many of us have invested heavily and repeatedly over the years, convinced and excited by the benefits to follow. Many of us have also known the brief honeymoon of interest and satisfaction which quickly evaporated into disappointment (Fig 1-1); another expen-

图 1-1 精心治疗后的又一次失败
Fig 1-1 Excitement and conviction evaporate into disappointment once again

事实上，根管治疗的操作技术要求很高，因此医师们希望找到一种更加简单、可靠、有效的方法取而代之。加上目前要求保存牙齿的患者不断增多，使得全球的口腔市场对牙髓治疗产品，如新材料、新设备的需求空前高涨。但冷静分析后，可以发现这些所谓的新材料、新系统过于注重技术本身及治疗后时尚的“外观”，而不是认真研究疾病的机制，以期找到治疗的最佳方法，因而这并不能算是真正意义上的新方法，而只是出于商业目的。

作为一本实用的根管治疗手册的

sive system relegated to the back of a dark cupboard in preference for an old trusty method, or to be superseded by the next bright hope.

The truth is that most of us find root canal treatment technically challenging, and wish there were simpler, more predictable and more efficient ways to do it. This, combined with a growing demand for tooth preservation, has seen unprecedented growth in world markets for endodontic product, and an insatiable hunger for new and attractively packaged materials and devices. To the dispassionate observer, this may seem to be pure commercial opportunism as we focus on technology and attaining the currently fashionable postoperative “look” rather than returning to the disease process and how it can best be managed.

At the start of a practical handbook on

开篇，了解牙髓病和根尖周病的生物学基础对于预防和治疗是非常重要的。只有这样才能使治疗的每一步合理化，同时比较出新旧技术的优劣，最终为获得最好的治疗效果选择适当的方法。

奠定基础：牙髓病学的生物学基础

根管治疗是防治根尖周炎的方法之一（图1-2a）。在西方社会，30岁以上人群中根尖周炎的发病率为40%，60岁以上可达到62%。

根尖周炎之所以重要，这是因为：

- 它可引起局部疼痛和不适。
- 急性炎症扩散可引起严重的并发症，甚至危及生命（如颌面部蜂窝织炎、脑脓肿）。

root canal treatment, it is important to ground ourselves in the fundamental biology of the pulp and periapical lesions we wish to prevent and heal. Only then can we rationalise the mechanical stages of treatment and reveal where new and older techniques can optimise operator efficiency and successful outcomes for patients.

Laying Foundations: The Basic Biology of Endodontic Disease

Root canal treatment is concerned with preventing and healing apical periodontitis (Fig 1-2a), a disease which affects 40% of over 30s and 62% of over 60s in western society.

Apical periodontitis is important because:

- It causes local pain and morbidity.
- Acute exacerbation can result in serious, potentially life-threatening extension (e.g. facial cellulitis, brain abscess).

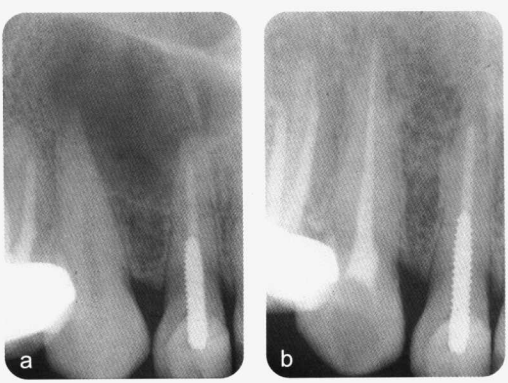

图1-2 a. 根尖周炎是西方社会中一种重要而常见的疾病；b. 病原因素控制后，根尖周炎症可以治愈

Fig 1-2 (a)Apical periodontitis, an important and common disease in western society. (b)Control of aetiological factors allows apical periodontitis to heal

- 与牙齿有关的慢性感染和炎症可能导致的全身并发症，这种观点正受到越来越多的关注。

由牙髓病变扩散引起的根尖周炎（图 1-5），可通过以下途径预防：

- 保持牙髓的健康。
- 在炎症累及根尖周组织之前治疗牙髓疾病（图 1-3）。

由髓腔内感染物引起的根尖周炎，彻底清除感染物并防止再感染，即可治愈根尖周炎（图 1-2a、b）。

牙髓损伤和牙髓坏死的病因学

牙本质和牙髓关系密切，所谓的"牙本质－牙髓复合体"被牙釉质和坚

- There are growing concerns about the possible systemic consequences of chronic infection and inflammatory lesions associated with teeth.

Apical periodontitis develops by extension of disease in the dental pulp (Fig 1-5). It can be prevented by:

- maintaining pulp health
- managing pulp disease before changes can progress to involve the periapical tissues (Fig 1-3).

Established apical periodontitis is caused by infected material in the pulp canal space and is known to heal predictably if the causative agents can be eliminated and prevented from returning (Fig l-2a,b).

The Aetiology of Pulp Injury and Death

Dentine and pulp are intimately related. In pristine health, the so-called "dentine-

图1-3 早期行根管治疗死髓牙可以减轻疼痛并防止根尖周炎症的扩散

Fig 1-3 Early root canal treatment of a tooth with a dying pulp relieves pain and prevents apical periodontitis from developing

硬的牙骨质完全密封起来。如果龋病、医源性医素或创伤（图1-4）将这层保护层破坏，多孔、管状的牙本质就会暴露于口腔环境，使牙髓易于受到化学、物理因素和细菌的损害。目前研究发现来自细菌的威胁是最严重的。

pulp complex" lies protected by an impervious layer of enamel and a sound investing periodontium. Breakdown of this protection by caries, operative dentistry or trauma (Fig 1-4) exposes porous, tubular dentine to the oral environment and leaves the pulp vulnerable to chemical, physical and microbial injury. The threat posed by microorganisms is by far the most serious.

口腔菌群和牙髓

20世纪60年代，研究者通过观察不同培养环境下（普通环境和无菌环境）暴露动物牙髓的实验证实了口腔菌群的毒力作用。随后用无菌动物进行的修复材料牙髓刺激性实验，以及通过牙齿表面封闭使牙髓处于无菌环境的实验，均得到相同的结果。目前有大量的证据支持以下观点：

- 如果处于无菌状态，牙髓具有很强的抵御机械性和化学性刺激

The Oral Flora and the Pulp

The virulence of the oral flora was demonstrated in the 1960s, when researchers investigated the effects of pulp exposure in normal and microbe-free animals. Similar observations have been made in subsequent studies on the pulpal irritancy of restorative materials in microbe-free animals and in surface-sealing studies where microbes where kept out of teeth. The overwhelming body of evidence currently supports the view that:

- If microorganisms are kept out of the pulp, it has remarkable capacity to

图1-4 直接暴露或通过牙本质小管间接暴露的牙髓，易受到化学、物理因素的刺激，特别是细菌的损害

Fig 1-4 Frank exposure of the pulp, or via porous dentine leaves it vulnerable to chemical, physical and above all, micro-bial injury

的能力。

- 修复体边缘的液体渗透和微生物对牙髓健康的损伤程度比酸和单体更严重。

- 口腔菌群及其毒素是导致牙髓发生重度炎症反应和牙髓坏死的原因。

牙外伤可使牙髓因根尖血供中断，发生无菌性、缺血性坏死而丧失活力，但大部分牙髓的坏死仍是在龋坏、充填龋坏的不断重复过程中由于细菌侵入造成的。约有 20%活髓冠修复的牙齿在20年中会出现牙髓活力丧失及根尖周炎，因此，在为 60 岁以下患者制定治疗计划时需要考虑到这些问题。

防止牙髓感染是预防牙髓坏死和根尖周炎的关键，这应当是所有牙科医师的基本治疗目标。不论我们的根管充填多么精确，最佳的根管充填物仍是健康的牙髓。因此，本书重点强调操作中对牙髓健康的保护，本系列丛书中另有一册讲述牙齿创伤的处理。

坏死的牙髓组织：根尖周炎的病因？

当牙髓受到激惹，感染的牙髓由

withstand and wall itself off from mechanical and chemical irritation.

- Acids and monomers are less of an issue for pulp health than the percolation of fluids and microorganisms at restoration margins.

- It is the oral flora and their toxins which seriously inflame and kill pulps.

Although a significant number of pulps lose vitality during traumatic events which sever their apical blood supply (sterile, avascular necrosis), most pulp death is still caused by microbial entry following repeated cycles of caries and dental intervention. Almost 20% of crowned teeth, for example, will have non-vital pulps and apical periodontitis within twenty years. This is a sobering reflection as we plan dental care for patients under the age of 60.

Avoiding pulp infection is key to preventing pulp death and apical periodontitis, and must be a fundamental goal of all dentists. However refined we become in root-filling teeth, the best root filling will always be a healthy pulp. A whole volume in this series is devoted to the preservation of pulp health in practice, and another to the management of traumatic injuries.

Dead Pulp Tissue: The Cause of Apical Periodontitis?

As pulp breakdown proceeds from the

外周向中央而后向根尖方向发生崩解时，根管内容物开始刺激周围组织，产生炎症（图 1-5）。作为经典诊断指标的 X 线检查所见的骨质吸收就是其后果之一。

过去，教科书将牙髓崩解产物和根管根尖部位的组织液滞留视为根尖

irritated and infected periphery to the centre, and then apically, canal contents begin to stimulate inflammation in the surrounding tissues (Fig 1-5). Radiographic evidence of bony resorption, the classic diagnostic sign, is one of the consequences.

Historically, textbooks have described stagnation and breakdown of pulp and tis-

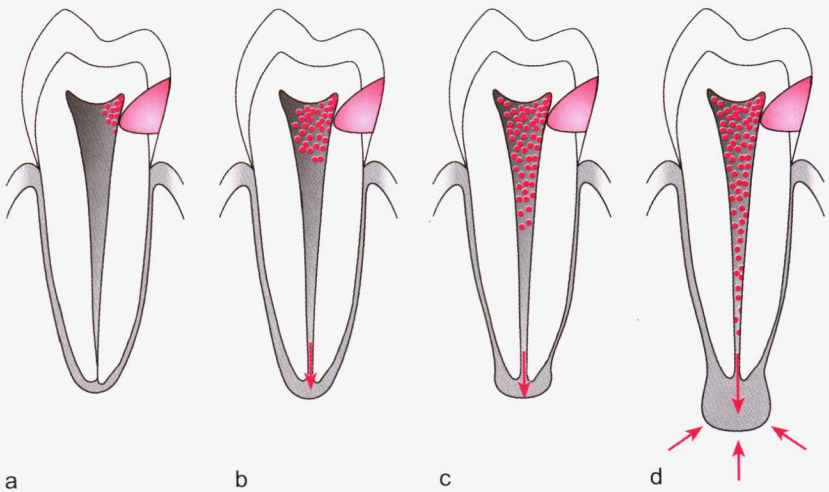

图 1-5 牙髓坏死的渐进过程。a. 龋坏使牙髓暴露后，细菌侵入牙髓，牙髓产生局部炎症反应以消除或局限感染； b,c. 如未经治疗，炎症向牙髓中心及根尖方向扩散直至牙髓全部坏死，发生早期的根尖炎症；d. 根尖周炎形成；试图阻止炎症的继续扩散，患者出现的症状体现出感染与宿主抵抗力之间的平衡关系。如早期发现牙髓发生进行性坏死，可行牙髓切断术

Fig 1-5 The gradual process of pulp death. (a) Invasion of the pulp by microorganisms following carious pulp exposure. The pulp mounts a local inflammatory response in an attempt to eliminate or contain the infection. (b,c) Without treatment, inflammation progresses centrally and apically until the whole pulp is dead. Apical inflammation commences early. (d) Established apical periodontitis; an attempt to contain the advance of irritants. Symptoms experienced represent a balance between the contained infection and host defences. The progressive death of the pulp allows successful pulpotomy if caught early

周炎的主要病因，但这种宿主物质是否足以激发和维持根尖感染呢？

20 世纪 70 年代的人体研究表明，在外伤使牙齿失去活力的病例中，只有那些根管感染的病例才发生根尖周炎，而牙髓无菌性坏死的牙齿并未出现这种变化。20 世纪 80 年代对灵长类动物的研究表明无菌状态下使牙髓失活不会导致根尖周炎，但如果加入有菌的涎液，根尖周炎很快就会发生。我们很多人都曾经遇到过以下情况：牙齿创伤后保持几个月或几年都无症状，突然在没有明显诱因的情况下出现疼痛并发展成为根尖周炎。其原因就是创伤后最初发生的是牙髓渐进性无菌性死亡，几年后由于细菌（有时甚至只有一个）侵入到营养丰富、温度适宜的培养基中，外来细菌为根尖周炎症的产生和维持提供了必需的外源性抗原刺激，从而引起临床可见的病变。

这表明：

- 仅仅坏死的宿主组织或阻滞的体液不足以引起和维持根尖周炎症，必须要有外源性抗原物质的存在。这里的外源性抗原是指

sue fluids in the apical part of the canal as major causes of this inflammation. But is this host material sufficiently irritant to provoke and sustain periapical inflammation?

Human studies in the 1970s showed that in teeth devitalised by trauma, only those with infected root canals developed apical periodontitis. Teeth with sterile, necrotic pulps showed no such changes. Primate studies in the 1980s also showed that aseptically devitalising a pulp does not cause apical periodontitis, but if infected saliva is added, apical periodontitis develops rapidly and predictably. Many of us have witnessed such events. Traumatised teeth can remain quiet and symptom free for many months or even years, then suddenly, without serious challenge, they become painful and develop apical periodontitis.The explanation is that the pulp died quietly and aseptically after the trauma. Many years later, the entry of microorganisms (perhaps even just one) to the rich, warm culture medium lying dormant within provided the necessary foreign antigenic challenge to establish and sustain periapical inflammation and the development of a clinically detectable lesion.

What does this mean?

- Periapical inflammatory lesions cannot be initiated or sustained by the presence of dead host tissues or stagnant body fluids alone. Foreign anti-

细菌感染。

- 临床所见的根尖周炎是根管感染的结果。
- 只有清除感染和防止复发才能治愈根尖周炎。

根管感染的特点

尽管口腔内的常驻菌超过200种，感染根管的环境压力通常只允许4～6种细菌在同一时间内克隆繁殖。根管内的大部分细菌为专性厌氧菌，兼性厌氧菌、嗜CO_2菌也很常见。

特异性感染或非特异性感染

目前尚不了解是否任意细菌群落发展到一定大小(也许很小)都可以引起根尖周炎，还是必须有某种或某几种特定的细菌才能导致其发生。研究发现多种细菌都可引起根尖周炎症，如在根管治疗失败和未经治疗的病例中检出的菌群就大不相同，但还从来没有发现健康根管中有常驻菌群。到目前为止，还不能判断菌群中哪些是引起炎症的"真正罪魁祸首"，哪些是"无辜的旁观者"，另外，还没有针对致病菌的特异性药物。因此我们姑且认

genic material must be present, and that means microbial infection.

- When we witness apical periodontitis clinically, we are observing the consequences of pulp canal infection.
- Apical periodontitis can only be expected to heal if the causative infection is eliminated and prevented from returning.

The Nature of Root Canal Infection

Whilst the mouth is inhabited by more than 200 microbial species, environmental pressures in the infected root canal typically limit colonisation at any one time to some 4-6 species. Most are strictly anaerobic, though facultative and CO_2-loving (capnophilic) isolates are common.

Specific or Non-specific Infection?

What we do not know is whether apical periodontitis is a response to a critical mass (perhaps very tiny) of any microorganism, or if there must be certain organisms or combinations present for a lesion to develop. Research suggests that a wide range of bacteria can produce periapical inflammation. The apical periodontitis-inducing flora in cases of failed root canal treatment, for example, differs greatly from that of previously untreated cases, and the existence of a "healthy" root canal flora has

为所有感染根管内的细菌都是有害的，都具有潜在致病性。庆幸的是，我们采用传统的消毒灭菌方法可以杀灭大多数细菌。

never been established. For the present, we cannot distinguish the true pathogens from the innocent bystanders, and have no specific drugs to target them. Any root canal infection must therefore be considered unwanted and potentially disease-inducing. Thankfully, our standard methods of disinfection are able to kill most of them.

罕见的难治性感染

图 1-6 所示的两名患者年龄上相差几十岁，临床病史也大不相同。研究发现两人所患的都是一种常见的细菌感染性疾病，但机体自身对此却无能为力。因为他们的感染局限于坏死的牙髓，宿主防御反应和任何一种全身应用的抗生素均无法到达此处。

An Unusual, Inaccessible Infection

The two patients shown in Fig 1-6 are separated by several decades, and present very different chnical histories. We have established that they share a common microbial disease, but neither is able to do anything about it. Their infection is contained in the avascular environment of the necrotic pulp space, inaccessible to host

图 1-6　两名年龄相差几十岁的患者，都患有一种常见的细菌感染性疾病，但机体自身却无法清除感染

Fig 1-6　Two patients, separated by several decades, share a microbial disease which they are unable to rid themselves of