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Obturation of the Root Canal System: Biological principles, Materials, and Techniques

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The ultimate objective of the root canal therapy is the three-dimensional obturation of the endodontic space after it has been completely cleaned, shaped and disinfected.

The purpose of obturation is to seal all “portals of exit” to impede any sort of communication or exchange between the endodontium and periodontium. It must therefore completely and durably fill the root canal space, in which no empty spaces should remain at all. It has been amply demonstrated that the vast majority of endodontic failures are related to incomplete obturation of the endodontium.^{41,71,163}

Before undertaking an examination of the techniques of canal obturation, the biological reasons for which a cleaned, shaped root canal requires obturation will be discussed. This will help in understanding which techniques can better assure a successful outcome.

BIOLOGICAL CONSIDERATIONS ON ROOT CANAL OBTURATION

In 1931, Rickert and Dixon¹²⁵ formulated the “hollow tube theory,” according to which an empty space within a living organism tends to fill with tissue fluids in a short period of time. This theory was based on the observation of an inflammatory reaction around the ends of hollow steel and platinum anesthetic needle fragments implanted in experimental animals. This reaction did not occur if the implant was made of a solid, non-porous material.¹²⁵

Two years later, Coolidge³³ arrived at the conclusion that, just as within unfilled or underfilled root canals, fluids that accumulate within empty spaces are

rapidly colonized by bacteria which reach these spaces by means of a phenomenon of “anachoresis”. In other words, bacteria transported by the blood circulation (bacteremia) colonized these areas, where they remained sheltered from phagocytosis by the organism’s defenses. In the tissue fluids that had collected, the bacteria found a nutritional source that could sustain them. The irritating substances derived from the breakdown of the organic material contained in the tissue fluid and from the products of the bacterial metabolism were supposedly the cause of the surrounding inflammatory reaction.

For years, this theory has influenced the concept that the root canals must be filled to the apex and therefore that any empty spaces must be completely obliterated: no unfilled portion of the root canal must serve as a reservoir for the accumulation of tissue fluids and inflammatory exudate, as this would quickly be colonized by bacteria through anachoresis, which would prevent or delay the healing of the periapical lesion.

More recent studies have questioned this postulate, demonstrating that it is possible in experimental animals to implant sterile empty glass¹⁴⁰ or polyethylene^{87,155} tubes or even empty root canals,³⁶ causing only mild inflammation or none at all around the open ends of the tubes.

Other authors⁶⁹ have demonstrated in experimental animals that empty spaces made inside plastic teeth implanted in fresh sockets did not produce any inflammation around the open ends, while in many cases these spaces were subsequently filled up with fibrous tissue or bone. The latter occurred more frequently with larger size apical openings.³⁶

These more recent studies, therefore, strongly invalidate the previous “hollow tube theory” and make it possible for us to conclude that empty spaces within a living tissue are not necessarily accompanied by inflammation or tissue destruction; on the contrary, they can be associated with physiological repair (Fig. 23.1).

In a recent article, Delivanis et al.³⁹ have denied the possibility of the existence of the anachoresis within an empty tube filled only with tissue fluids or within a root canal following pulpectomy, in experimental animals. The selective localization in areas of chronic inflammation of blood-borne bacteria (anachoresis) is a well known phenomenon, experimentally demonstrated.^{1,19,54,101,104,145} For example, it explains the implantation of bacteria in a pulp that has not been exposed to the oral environment but has been compromised by a trauma. In order for the anachoresis to occur, the presence of blood vessels are, however, necessary: bacteria can easily localize in a space where tissue is present, even inflamed or on the way to necrosis, but still with

blood circulation and not simply in a space filled only with tissue fluids where no blood circulation exists.

From all this it has been concluded that cleaned and shaped root canals must also be completely obliterated, not to prevent the bacterial colonization of the tissue fluids, but rather to prevent the survival and multiplication, inside the fluids which inevitably accumulate there, of bacteria remaining from even the most thorough sterilization procedures of the root canal.

It is universally recognized that complete sterilization of an infected root canal is very difficult, if not impossible, to achieve, just like the complete removal of all pulpal debris,^{11,20,21,109,156,158} (Fig. 23.2).

The microorganisms remain isolated inside the root canal system, possibly within dentinal tubules that have remained infected deeper than the level of the shaped dentinal wall.¹³¹ They therefore are beyond the reach of the organism’s phagocytic defenses, and the presence of necrotic pulp remnants in association with the accumulating exudate can serve as a “pabulum” and contribute to the maintenance of their viabilities.

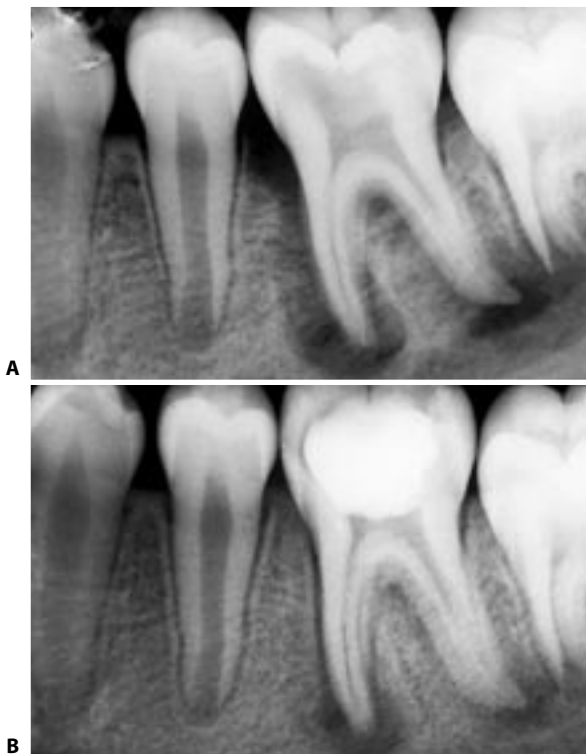


Fig. 23.1. **A.** Preoperative radiograph of a lower left first molar. **B.** Radiograph two months later. This period of time elapsed because of neglect on the part of the young patient. The four canals had been cleaned, shaped, and medicated with Cresatin. Note the progression of the healing process, which has proceeded in spite of the fact that the canals had not yet been obturated and thus were completely empty.

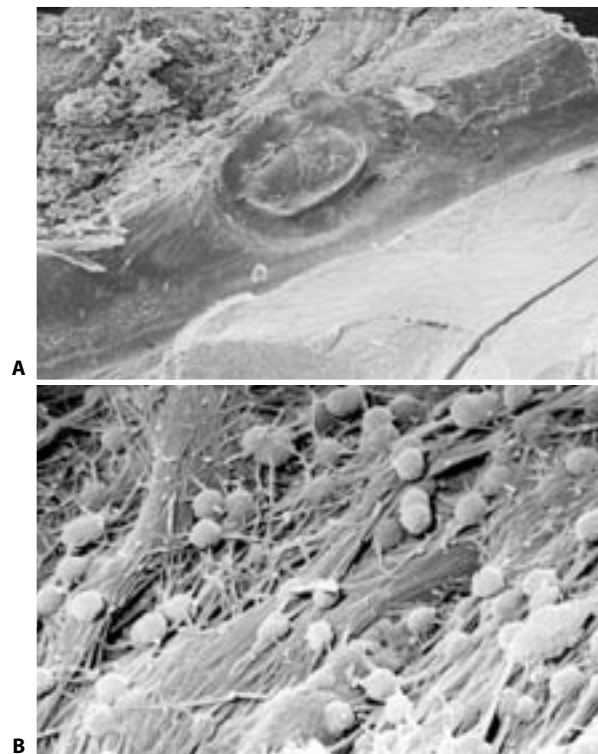


Fig. 23.2. **A.** S.E.M. view of the apical third of a cleaned and shaped lower incisor. Note the presence of a large calcification adhering to the wall a few millimeters from the foramen (x60). **B.** Detail of the preceding figure. Note the presence of organic material in the area immediately apical to the calcification, where the instruments obviously could not be worked (x4,000).