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Single-visit root canal treatment: an efficient clinical approach or merely a time-saving strategy? - A review of the current evidence

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Abstract
Single-visit Root Canal Treatment (RCT) has evolved from early experimental procedures in the 19th century to a viable, technology-driven approach in modern endodontics. This review traces its historical development, examines the scientific evidence comparing single- and multiple-visit protocols, and highlights their respective advantages and limitations. Literature consistently shows comparable clinical and radiographic success rates between both approaches, with single-visit RCT offering benefits such as reduced treatment time, decreased inter-appointment contamination risk, and improved patient convenience. However, challenges remain, including potential incomplete disinfection in complex anatomy, longer chair time, and higher technical demands. Advances in imaging, instrumentation, and obturation techniques have improved the predictability of single-visit RCT, making case selection crucial. Current evidence supports its use in appropriately indicated cases, while emphasizing clinician expertise and individualized treatment planning.

Keywords: Single-visit root canal treatment, multiple-visit root canal treatment, endodontics, clinical outcomes, case selection, treatment planning

1. Introduction
The root canal system, a space within the dentin that encloses the dental pulp, is crucial for preserving tooth vitality. When this delicate tissue becomes inflamed or infected, root canal therapy is undertaken to remove the damaged pulp, eliminate infection, and establish an environment conducive to healing, thereby preventing the progression of periapical disease. The term "endodontics" originates from the Greek words endo (inside) and odont (tooth), denoting treatment of the internal tooth structures and specifically the pulp tissue [1].
Historical evidence indicates that treatment "within a tooth" dates back to approximately 200 B.C., when archaeologists discovered a human skull in the northern Negev desert containing a tooth with a 2.5 mm bronze wire, believed to have been used by the Romans to treat pulp infection [2]. In the centuries that followed, drainage of root canal infections was employed as a method of pain relief [3]. This remained, alongside extraction, the primary approach to managing infected root canals until the 17th century.
In 1687, Charles Allen published The Operator for the Teeth, the first English-language book devoted exclusively to dentistry [4]. In it, he described procedures such as the transplantation of teeth, involving the removal of diseased teeth or roots and replacing them with sound teeth extracted from another individual [5]. Almost thirty years later, in 1729, Pierre Fauchard widely regarded as the father of modern dentistry published Le Chirurgien Dentiste. This text included detailed descriptions of pulp cavities, root canals, and techniques for opening teeth to drain abscesses and evacuate pus [4].
During the late 1700s and early 1800s, numerous methods for endodontic treatment were explored, but a major advance occurred in 1838 when Edwin Maynard designed the first instrument specifically for root canal therapy by modifying a watch spring [4, 5]. In 1847, Edwin Truman introduced gutta-percha into dentistry a root canal filling material that continues to be used extensively in clinical practice [4].
In the 20th century, root canal treatment evolved into a recognized dental specialty. In 1908,

G.V. Black introduced techniques for measuring canal lengths, which significantly improved treatment outcomes. Later, in 1956, Ingle and Levine standardized endodontic instruments, ensuring consistent and effective practice. The term "endodontics" was coined by Harry B. Johnston, establishing the field's distinct identity. By 1963, the American Dental Association officially acknowledged endodontics as a specialty, highlighting its significance in dental health [4].

Emergence of single visit RCT

Historically, root canal therapy was performed over multiple visits, primarily to ensure complete disinfection of the root canal system prior to obturation. As biomechanical preparation and irrigation alone could not achieve full sterilization, intracanal medicaments were employed to aid in bacterial elimination. These medicaments most commonly phenolic compounds were effective antimicrobial agents but also highly irritating to periradicular tissues [6, 7]. Excessive or improper use often resulted in postoperative complications, which were mistakenly attributed to persistent periradicular infections. This misinterpretation led to the unwarranted and frequent prescription of systemic antibiotics. Recognition of the adverse effects associated with such medicaments ultimately led to their discontinued routine use, prompting two treatment pathways: either performing root canal therapy in a single visit or identifying intracanal medicaments that would be effective without harming periradicular tissues [6].

The concept of single-visit root canal treatment was documented as early as the 1880s [8]. At that time, treatment techniques were rudimentary, and reported success rates were low. The approach was reintroduced in the 1950s by Ferranti, who recommended pulpal disinfection via diathermy and irrigation with hydrogen peroxide [9]. While these methods differed considerably from current practice, Ferranti emphasized that thorough canal shaping and cleaning were the most critical factors for success. Subsequently, in 1970, Tosti reported favorable outcomes using a single-visit protocol, although his clinical study was limited by a small sample size [10].

In the healthcare field, changing established treatment procedures can be a slow and challenging process. Professionals are often hesitant to move away from tried-and-true methods, fearing that adopting new approaches might not yield the same successful outcomes they have come to rely on. As new evidence emerges, it becomes crucial to expand our understanding and adjust our practices to include the latest advancements in instrumentation, techniques, materials, and technology [11]. This progress raises the question of whether we should reconsider and reassess our long-established concepts?

Bright spots vs. blind spots of single visit RCT [12, 13]

One of the key advantages of single-visit endodontic therapy is the reduced number of appointments required, making it highly convenient for patients with busy schedules. By completing the procedure in a single session, it not only saves time but also enhances patient comfort by eliminating the need for multiple visits.

Another major benefit is the decreased risk of inter-appointment microbial contamination. Unlike traditional multi-visit treatments that rely on temporary seals, which can leak or fail, single-visit therapy eliminates this risk, thereby minimizing the chances of infection and flareups.

For anterior teeth, single-visit therapy offers the advantage of immediate aesthetic restoration. Patients can leave the clinic with their smile fully restored, which is especially important for those concerned about their appearance. From a financial perspective, single-visit therapy is cost-effective. The reduced clinic time lowers costs for both patients and practices.

Despite the advantages, single-visit root canal therapy is not without its challenges. One of the primary concerns raised by critics is the potential for incomplete disinfection of the root canal system. Root canal systems are complex, with multiple branches and irregularities that can be difficult to clean and disinfect thoroughly in a single appointment. While modern instruments such as rotary files and activation of irrigation solutions have made it easier to clean the canals, The rationale behind single visit RCT is to entomb the residual bacteria and cut their nutrient supply which will render them powerless however some studies suggest that they may still read to reinfection [13].

Another significant drawback is the extended duration of the appointment, which can be exhausting and uncomfortable, particularly for patients with temporomandibular joint dysfunction or limited tolerance for long procedures.

Managing flare-up cases in a single visit is another challenge, as these situations often require more time and may not be fully resolved in one session. Additionally, complications such as haemorrhaging or exudation during the procedure can be difficult to control, making it challenging to complete the treatment in a single visit.

Complex cases, such as those involving narrow, calcified, or multiple canals, can also be a limitation of this approach. These cases often demand more time and precision, which can result in undue stress for both the patient and the clinician.

Finally, single-visit therapy requires a high level of expertise from the clinician. Successfully treating a case in a single session demands advanced skills and experience. Clinicians who are less proficient in this method may struggle to achieve optimal results, potentially compromising the quality of care.

One-visit vs. multiple-visit root canal: What's the difference?

Single-visit root canal therapy is designed to complete the entire sequence of treatment instrumentation, disinfection, and obturation within a single appointment [14]. This approach is grounded in the entombment theory, which proposes that the majority of microorganisms are removed during the cleaning and shaping phase, while any residual bacteria are sealed within the canal by the obturation material. This physical barrier deprives them of essential nutrients and space, ultimately leading to their inactivation [15].

In contrast, multiple-visit root canal therapy divides the treatment into at least two sessions. In the initial visit, the majority of instrumentation is completed, followed by placement of an intracanal medicament to suppress or eradicate remaining microorganisms before obturation is carried out at the subsequent appointment. Disinfection is achieved primarily through irrigation in both visits, with the medicated dressing serving to further lower bacterial counts between sessions [14]. This staged approach prioritizes the reduction or elimination of microorganisms and their byproducts, thereby optimizing the conditions for a successful obturation [16].

Mapping the terrain of literature

Recent systematic reviews have explored various aspects of single-visit endodontic therapy. A review assessing single-visit treatment under general anaesthesia in adult and

adolescent patients with special needs concluded that, although evidence is limited, the approach is feasible and can achieve favourable outcomes. However, the paucity of studies, potential publication bias, and methodological limitations highlight the need for further research [17].

A systematic review comparing single-visit and multi-visit endodontic retreatment in secondary infections included six studies, of which four evaluated postoperative pain and two assessed periapical lesion healing over 18- and 24-month follow-ups. Comparative analysis showed no significant differences in pain levels or healing outcomes between approaches. The adjunctive use of intracanal medicaments such as calcium hydroxide or triple antibiotic paste showed potential in reducing postoperative discomfort [18].

A meta-analysis of randomized clinical trials evaluating postoperative pain following endodontic retreatment found that single-visit procedures were associated with lower pain levels, suggesting this option may be appropriate in select clinical scenarios [19]. In contrast, an animal-study-based systematic review found that two-visit treatment using calcium hydroxide intracanal medication produced superior biological repair characteristics compared with single-visit protocols [20].

Another review of five randomized controlled trials (513 cases) compared periapical healing rates between single- and multi-visit treatments for necrotic teeth with apical periodontitis. Radiographic healing was observed in 83.4% of single-visit cases and 81.8% of multi-visit cases, with no statistically significant difference [21].

Meta-analyses on postendodontic pain and flare-ups have shown no significant differences between single- and multi-visit treatments, indicating that the number of appointments is not an independent determinant of postoperative complications [15, 22]. However, in protocols targeting endotoxin reduction, multi-visit treatment with calcium hydroxide applied for 14-30 days was significantly more effective than single-session treatment or a 7-day medicament placement [23].

A review comparing short-term postoperative pain found that single-visit treatment carried a slightly higher risk (1.02 times) than multi-visit treatment, though differences were modest and within acceptable heterogeneity limits [24]. Another review assessing clinical and radiographic outcomes in apical periodontitis cases found similar success rates for both approaches [25].

An overview of systematic reviews concluded that repair and success rates are comparable between single- and multi-visit endodontics, with a slight trend toward fewer postoperative complications in single-session cases [26]. Similarly, a meta-analysis of 17 randomized controlled trials found no differences in periapical repair or microbial control, but single-visit treatment was associated with 21% less post-obturation pain, supporting its use in public healthcare to improve access and efficiency [27].

A broader meta-analysis involving 29 trials (4341 patients) found no significant differences in complications or pain between the two approaches; however, flare-up incidence was higher in single-visit cases. Trial-sequential analysis indicated insufficient evidence to draw definitive conclusions [28].

Finally, a systematic review examining factors linked to post-obturation pain in single-visit nonsurgical treatment identified several preoperative and procedural variables including patient demographics, tooth type, preoperative symptoms, anesthetic choice, working length determination method, instrumentation, irrigation systems, obturation technique, and occlusal reduction that influence postoperative outcomes [29].

Navigating short-term and long-term complications

Following root canal treatment, teeth may present with complications in both the short and long term. Short-term complications often involve postoperative inflammation of the periapical tissues, which can manifest as mild discomfort or, in more severe cases, a flare-up defined as an acute exacerbation of pulpal or periapical pathosis characterized by intense pain and/or swelling. Such pain and swelling are frequently associated with the inadvertent extrusion of irrigants, medicaments, infected debris, or microorganisms into the periapical region during instrumentation or irrigation. Inadequate canal preparation and insufficient disinfection can also permit bacterial persistence within the canal system, leading to recontamination of periapical tissues [17, 18].

Long-term complications are typically the result of unresolved inflammation or persistent infection. These may present clinically and radiographically as periapical abscesses, sinus tract formation, radiolucent lesions indicative of periapical bone resorption, or chronic pain. In such cases, further intervention such as endodontic retreatment or extraction may be required [19, 20].

Flare ups

A systematic review, meta-analysis, and trial sequential analysis assessing complication risks associated with single- versus multiple-visit root canal treatment concluded that either approach can be performed effectively. However, due to a potentially higher risk of flare-ups in single-visit cases, multiple-visit treatment may be preferable for selected teeth, particularly those presenting with periapical lesions [14].

Postoperative pain

A recent systematic review and meta-analysis evaluating the incidence and intensity of post-endodontic pain and flare-ups in single- versus multiple-visit root canal treatments found no significant difference between the two approaches. Pain incidence and severity were comparable, suggesting that the decision on the number of visits should be guided by the clinical requirements of each individual case [15].

Healing

A systematic review of studies on single- and multiple-visit endodontic treatments reported similar success and repair rates across both methods, irrespective of pulp or periapical status. In cases of apical periodontitis, single-visit treatment demonstrated a slight advantage, showing fewer postoperative complications and marginally greater efficiency [21]. These findings are consistent with another systematic review and meta-analysis assessing the treatment of teeth with apical periodontitis, which found a 6.3% higher healing rate in single-visit treatments compared to multiple visits; however, this difference was not statistically significant [22].

The available evidence shows no significant difference in the effectiveness of single-visit versus multiple-visit root canal treatments, both in terms of radiologic and clinical success. Neither single-visit root canal treatment nor multiple-visit root canal treatment can prevent 100% of short-term and long-term complications.

Advancing efficiency: How technology enhanced single-visit root canal treatment

Technology has revolutionized single-visit Root Canal Treatment (RCT), making it faster, more efficient, and more precise. Direct digital radiography provides instant, high-quality images for real-time assessment of the root canal

system. The surgical microscope enhances accuracy by offering magnified views, ensuring thorough cleaning and shaping. Apex locators help precisely determine canal length, reducing the need for multiple X-rays and minimizing the risk of over-instrumentation. The crown-down technique efficiently prepares the apical portion of the canal while preventing the push of debris and bacteria into the periapical area. NiTi rotary instruments and ultrasonic devices speed up canal preparation, while irrigants like NaOCl along with activation ensure quick and effective debris removal. Finally, thermoplasticized injectable gutta-percha enables rapid, reliable obturation, providing a tight seal and reducing the risk of reinfection. With these technological advances, single-visit RCT is now a highly effective and convenient option for many patients.

Conclusion

Single-visit Root Canal Treatment (RCT) has evolved into an efficient and effective solution, offering a convenient alternative for patients seeking quicker dental procedures. Over time, advancements in technology and techniques have significantly improved the success rate of single-visit RCT, making it a viable option for many. The benefits of single-visit RCT include reduced treatment time, lower risk of microbial contamination between appointments, and the ability to restore aesthetics in a single session for anterior teeth, ultimately enhancing the patient experience.

However, there are challenges to consider, such as the potential for incomplete disinfection in complex root canal systems and the need for skilled clinicians to ensure the best possible outcomes. Additionally, issues like flare-ups, post-treatment complications, and the extended duration of the procedure can pose difficulties for both patients and practitioners.

Nevertheless, research indicates that single-visit RCT can achieve comparable success rates to multiple-visit treatments, with no significant differences in healing or clinical outcomes.

Technological innovations such as digital radiography, surgical microscopes, apex locators, and NiTi rotary instruments have made single-visit RCT more precise and effective, helping to overcome previous limitations.

Ultimately, the choice between single-visit and multiple-visit RCT should be based on the specifics of each case, including the complexity of the root canal system and the overall condition of the tooth. As technology continues to evolve, single-visit RCT will likely become an even more reliable and preferred option for patients seeking high-quality endodontic care.

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