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Review Article

Minimally invasive biological treatment in endodontics

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ABSTRACT

Functional forces might also lead to fracture after endodontic treatment. This might occur secondary to exposure to erosion, abrasion, physical trauma, and caries. Interventing against these events can be achieved by conducting long follow-up periods and enhancing the endodontic treatment approaches. The current endodontic treatment modalities aim at tissue preservation to enhance resistance to fractures and prevent potential post-treatment complications. In this context, evidence shows the validity of minimally invasive modalities in endodontic treatment with favorable outcomes and reduced frequency of complications. In the present literature review, we have discussed the efficacy of minimally invasive biological treatment in endodontics. It is vital to maintain the integrity of the structures of the tooth-related paracervical area, particularly when treating molars. This is attributed to enhancing the long-term survival rates of the pericervical dentin of these teeth. The current trends represent a revolution in the field of endodontic treatment. This is attributed to the novel development of the various disinfection modalities, which do not need to shape the canal into a round form and induce flaring reactions. Overall, the main advantages of vital pulp therapy include being simple, reduced cost, and reduced risk of treatment-related complications secondary to overcoming the difficulties with the anatomy of the root canals.

Keywords: Endodontics, Minimally-invasive, Treatment, Biological treatment, Outcomes, Efficacy, Root canal preparation

INTRODUCTION

Long-term survival of endodontically treated teeth has been reported as a valid measurement for evaluating the success of the treatment procedure. However, it should be noted that such success rates depend not only on endodontic treatment but also on achieving adequate obturation to intervene against the development of any bacterial pathogens and plaque formation, which might worsen the prognosis.[1] Performing adequate coronal seal has been reported to intervene against these events and enhance the predictive treatment outcomes.[2] In addition,

functional forces might also lead to fracture after endodontic treatment. This might occur secondary to exposure to erosion, abrasion, physical trauma, and caries.[3] Interventing against these events can be achieved by conducting long follow-up periods and enhancing the endodontic treatment approaches.

The current endodontic treatment modalities aim at tissue preservation to enhance resistance to fractures and prevent potential post-treatment complications. In this context, evidence shows the validity of minimally invasive modalities in endodontic treatment with favorable outcomes and reduced frequency of complications.[4,5] The primary aim of these approaches is to maximize the conservation and preservation of the dentinoenaml junction, dentin, and enamel and prevent extension.[6,7] Many investigations in the literature have discussed the efficacy of these approaches in endodontic treatment. Therefore, we aimed to collect evidence from these investigations to provide a discussion regarding minimally invasive biological treatment in endodontics.

METHODS

This literature review is based on an extensive literature search in Medline, Cochrane, and EMBASE databases which was performed on 15 November 2021 using the medical subject headings (MeSH) or a combination of all possible related terms, according to the database. To avoid missing potential studies, a further manual search for papers was done through Google Scholar while the reference lists of the initially included papers. Papers discussing minimally invasive biological treatment in endodontics were screened for useful information. No limitations were posed on date, language, age of participants, or publication type.

DISCUSSION

The volume of removed dentin when performing root canal treatment has been reported to correlate with the incidence of vertical root fractures significantly in the treated teeth. However, it has been evidenced that various mechanisms can modify this factor that can lead to root preservation and reduce the incidence of root fractures during endodontic treatment.[8] Therefore, the mechanical and biological parameters that are usually approached to access the root cavity should include the novel minimally invasive approaches, including the capability to unroof, funnel, and physically penetrate the pulp chamber.[9] In addition, trends in endodontic treatment indicate a shift in decreasing the amount of removing operated tooth structure. Current trends indicate that endodontic treatment should focus on the size of the access cavity and the specific location of the lesion rather than the traditional access design. Different strategies were developed to replace the traditional access site. These include conservative and constructed endodontic cavities and the Ninja outline.[10-12] X-entry access cavity design was also reported in the literature.[13] This strategy aims to reduce the amount of dentin removal from the vital pulp structure. It is worth mentioning that is it is vital to maintain the integrity of the structures of the tooth-related paracervical area, particularly when treating molars. This is attributed to enhancing the long-term survival rates of the pericervical dentin of these teeth. Evidence shows that dentin is considered the neck of this tooth in molars. Therefore, its protection can significantly reduce the incidence of fractures and enhance the ferrule.[9] Avoiding collateral damage, including gouging of the lateral wall, should also be considered by maintaining the integrity of the soffit.[12,14,15]

Various technological advances have been introduced to the field of endodontics regarding materials and techniques. Since the 1990s, when the laser was first introduced to endodontics, many other advances have been reported in the literature, including ever-more-flexible nickel-titanium rotary instruments (Figure 1).[16] In this section, we will discuss the conservative instrumentation of root canals. It is well known that the anatomical structure of root canals is a complex one, which might be variable from oval to asymmetric structures.[17] Using large coronal tapers has been used as the traditional approach of root canal instrumentation to provide a suitable form for obturation and enhance disinfection and irrigation of the root canal.[18] However, it has been shown that the amount, distribution, integrity, and strength of the remaining teeth structures significantly determine tooth survival.[19] The current approaches of minimally invasive biological endodontic treatment aim at achieving the best prognostic outcomes regarding tissue preservation because the best biological value is usually determined by the health status of the original tissues.[20] In this context, evidence shows that minimally invasive endodontic treatment outcomes have been significantly enhanced following instrumentation armamentarium. The current trends represent a revolution in the field of endodontic treatment. This is attributed to the novel development of the various disinfection modalities, which do not need to shape the canal into a round form and induce flaring reactions.[21,22]

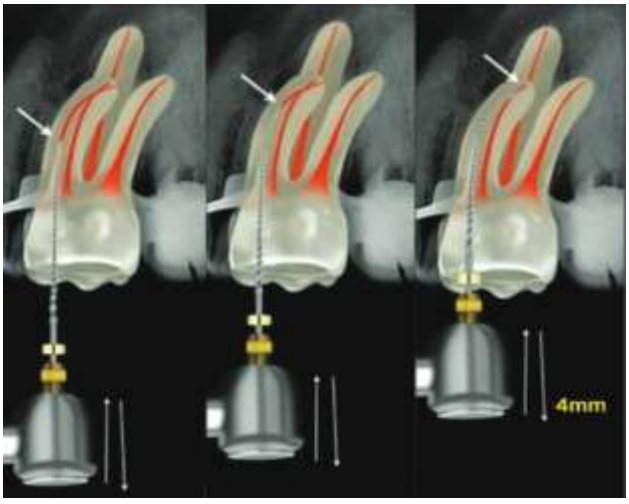

Figure 1: Using nickel-titanium instrumentation in endodontics.[23]

According to the technological advances in the field, it has been demonstrated that clinicians aim to achieve a continuous taper and smaller apical instrumentation rather than the traditional approaches that are aimed at providing larger apical diameters and enhanced apical instrumentation.[24,25] In this context, evidence shows that weakened tooth structures might result from larger apical diameters. In addition, evidence indicates the efficacy of the novel minimally invasive endodontic treatment approaches in eliminating bacteria in a similar efficacy to the traditional conservative management. In this context, it has been shown that enhanced treatment outcomes as obtaining more efficaciously centered preparations that need less straightening can be done by approaching endodontic treatment by nickel-titanium instruments and super-elastic rotary, not the conventional stainless steel.[26,27] Many advances in this field were also reported with root canal irrigation. There are continuous updates in this field because the current approaches have certain limits in removing and cleaning root canals from all toxic materials that can worsen treatment prognosis. In this context, the current investigation has concentrated on physical parameters that can significantly facilitate cleaning and disinfection, like laser activation, photo, ultrasonic, and sonic-induced photo-acoustic streaming.[28,29]

Studies also compared the efficacy of Gentle Wave system (Sonendo, Inc., Laguna Hills, CA) and Endo-Vac, ultrasonic irrigation, and conventional irrigation systems.[30,31] It has been indicated that the minimally invasive approach has been correlated with an 8-fold increase in the efficacy of tissue dissolution. In addition, it has been furtherly demonstrated that these approaches can remove calcium hydroxide in a more enhanced way, even within the apical third of the teeth. Within six months from the initial endodontic treatment with Gentle Wave system, a previous in vivo investigation reported successful healing following root canal treatment was observed among 97.4% of the total cases. In this investigation, the authors furtherly reported that 97.2% of the tissue debris was successfully removed by the Gentle Wave system in the middle and apical third of mandibular molars mesial roots and the isthmus.[32] Minimally invasive endodontic treatment has also been designated to treat irreversible cases with pulpitis. New insights on the biology of the pulp have been introduced secondary to these advances. In this context, previous studies showed that the radicular pulp was remarkably viable while the principle necrotic and inflammatory changes occurred in the coronal pulp.[33-35] Furtherly reported that the treatment outcomes are similar between vital pulp treatment and conventional endodontic treatment.[36] This has been partially attributed to the potential biological immune response following vital treatment of root canals directed to prevent further infection of the apical pulp and improve treatment outcomes.

Avoiding pulpectomy and retaining radicular pulp tissues have been recommended by previous experts. This has been associated with the preferable conservation of the tooth's defensive and physiological functions. In addition, this will significantly result in stronger teeth secondary to preserving the hard tissues.[35] Overall, the main advantages of vital pulp therapy include being simple, reduced cost, and reduced risk of treatment-related complications secondary to overcoming the difficulties with the anatomy of the root canals. In addition, postoperative pain was also reported among patients who underwent vital pulp therapy compared with conventional endodontic treatment.[34] However, it should be noted that vital pulp therapy should be conducted based on strict treatment protocols and the proper selection of suitable cases.[37]

Evidence shows that guttapercha sealer or warm condensation multiphase techniques are commonly used in endodontics treatment. However, it has been demonstrated that these approaches are associated with microleakage complications. This is due to the shrinkage of the guttapercha sealer following warm condensation and reduced chemical bonding and adhesion between filling materials and walls of the root canals. Therefore, bioceramic-based sealers have been introduced as efficacious alternative approaches for managing these events and enhancing the treatment outcomes. In addition, it has been demonstrated that these materials have better bonding abilities together with adhesive and hydrophilic characteristics. Accordingly, it has been demonstrated that these modalities have better filling materials because of these characteristics, enabling them to spread over the dentin walls easily. Therefore, the need to perform risky traditional filling approaches is reduced. Besides, it has been shown that using bioceramic materials decreased the incidence of root fractures and enhanced the rates of tissue preservation.[38] In addition, the evidence demonstrated that fracture resistance had been significantly enhanced with using bioceramic materials in endodontic treatment. This has been indicated following the application of iRoot SP, particularly when combined with bioceramic-coated and impregnated guttapercha cones.[39,40] Similar outcomes were also noticed in immature roots and mature roots when MTA Fillapex, Endosequence sealer, and AH plus.[41]

Conducting immediate dentin sealing was also proposed in the literature as a valid and productive approach adopted during endodontic treatment. In addition, it has been evidenced that immediate sealing is significantly associated with long-term outcomes that are better than those obtained using resin sealers alone, which is associated with delayed sealing outcomes.[42-44] To achieve immediate dentin sealing, a 3-step etch-and-rinse dentin bonding agent was evaluated in mean micro tensile bond strength with delayed dentin bonding. It has been shown that immediate dentin sealing was significantly associated with a 5-time higher strength than delayed dentin healing.[45] Studies also show that delayed exposure to occlusal loading and delayed restoration placement, secondary to performing indirect restorations with immediate dentin sealing, were associated with more maturation and development of the dentin bond with minimal stress.[6,7]

The selection of restorative material is an important step before conducting endodontic treatment that determines the prognosis of the treatment process. For instance, it has been shown that using endocrowns is associated with favorable outcomes in endodontically treated teeth.[6,7] In addition, studies concluded that these modalities could significantly preserve functions of the healthy tissues and save time during endodontic treatment. Reduced stress and increased fracture rates were also demonstrated with endocrowns compared with the traditional therapeutic approaches. Accordingly, evidence shows that endodontic treatment should be conducted using minimally invasive preparations as the gold standard to achieve favorable outcomes regarding tissue preservation.[46,47] Previous investigations in the literature based on laboratory studies showed that the outcomes when endocrowns were used were similar to when fiber post-composite cores and all crowns were used.[48] The long-term success rates of endocrowns were reported to range between 75% and 100% based on long follow-up periods that lasted for up to 12 years.[49,50]

CONCLUSION

It is vital to maintain the integrity of the structures of the tooth-related paracervical area, particularly when treating molars. This is attributed to enhancing the long-term survival rates of the pericervical dentin of these teeth. The current trends represent a revolution in the field of endodontic treatment. This is attributed to the novel development of the various disinfection modalities, which do not need to shape the canal into a round form and induce flaring reactions. Overall, the main advantages of vital pulp therapy include being simple, reduced cost, and reduced risk of treatment-related complications secondary to overcoming the difficulties with the anatomy of the root canals.

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