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Jonathan Navarro Andrade
Student, Master of Science, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Jorge Jaime Flores Treviño
Professor, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Idalia Rodriguez Delgado
Professor, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Aurora Lucero Reyes
Professor, Universidad Autonoma de Tlaxcala, Facultad de Odontologia, Tlaxcala, Mexico

Elvia Ortiz Ortiz
Professor, Universidad Autonoma de Tlaxcala, Facultad de Odontologia, Tlaxcala, Mexico

Maria Argelia Akemi Nakagoshi Cepeda
Professor, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Angela Benitez Santos
Student, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Juan Manuel Solis Soto
Professor, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Corresponding Author:
Jonathan Navarro Andrade
Student, Master of Science, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Minimally invasive endodontics, an overview and current update

Jonathan Navarro Andrade, Jorge Jaime Flores Treviño, Idalia Rodriguez Delgado, Aurora Lucero Reyes, Elvia Ortiz Ortiz, Maria Argelia Akemi Nakagoshi Cepeda, Angela Benitez Santos and Juan Manuel Solis Soto

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Abstract
Introduction: The small access cavities could make it more difficult to visualize the pulp chamber as well as to locate, shape, clean and fill the canals. At the same time, increase the risk of iatrogenic complications. (Silva *et al*., 2020)
Objective: To analyze the literature concerning the influence of minimally invasive endodontic access in pulp therapy, in relation to the degree of disinfection, degree of conformation, quality of obturation and resistance to the fracture.
Methodology: By searching in electronic databases such as PubMed, using keywords: "minimally invasive endodontics", "degree of disinfection", "shaping", "obturation" and "resistance to fracture".
Results: A true compromise of the degree of conformation of the canal is not demonstrated, although neither a benefit, when performing a contracted endodontic cavity (CEC). It is not possible to reach an adequate conclusion about the degree of disinfection in a CEC; priority should be given to a traditional endodontic cavity (TEC). Efficient canal obturation in CEC is limited to a single obturation technique, but if it is not intended to work under this protocol, the use of a TEC is suggested. No noticeable change in fracture strength is demonstrated in a CEC over a TEC.
Conclusions: Success of endodontic treatment is represented by each of the stages that make up the procedure. CECs are an alteration to the traditional protocol and with it to the rest of the treatment stages.

Keywords: Endodontics, obturation, minimally invasive, disinfection, fracture

1. Introduction
Small access cavities may make it more difficult to visualize the pulp chamber and to locate, shape, clean and obturate the canals. As well as increasing the risk of iatrogenic complications [1].

Endodontic therapy is a common dental procedure used for the treatment of teeth where the pulp tissue has become irreversibly inflamed or necrotic [2]. The main objective of root canal treatment is to remove bacteria through biomechanical preparation and complete obturation of the root canal system. Traditionally, the technical stages of root canal treatment are described as "access, cleaning, shaping and obturation" [3].

The preparation of the access cavity is one of the most important stages of root canal therapy [4]. Traditional endodontic access emphasizes straight pathways into the root canals to increase effective preparation and prevent procedural errors [5].

The new concept of minimally invasive access cavities aims to preserve healthy dentin by maintaining as much of the pulp chamber roof as possible, based on the assumption that maintaining this structure will preserve the fracture resistance of the tooth following root canal treatment. However, creating endodontic accesses that are too small can compromise subsequent stages of treatment, complicating the location of canal entrances and cleaning, such as the canal shaping and obturation stages [1]. Recently, the concept of minimally invasive endodontics is gradually gaining acceptance among dentists, despite the limited scientific evidence in favor of this concept [6].

This research is conducted seeking to understand the factors that could determine the success or failure of treatment based on new trends in endodontic access. The aim of this study was to analyze the literature concerning the influence of minimally invasive endodontic access on pulp therapy in relation to the degree of disinfection, degree of shaping, quality of obturation and resistance to fracture.

2. Materials and Methods

Information from articles published in PubMed, Science Direct and EBSCO was analyzed with emphasis on the last 5 years. The quality of the articles was analyzed based on the PRISMA guidelines, i.e., identification, review, choice, and inclusion. The quality of the review was assessed using the measurement instrument for evaluating systemic reviews (AMSTAR-2) [7]. The search was performed using Boolean logical operators AND, OR and NOT. It was realized with the words "minimally invasive endodontic", "degree of disinfection", "shaping", "obturation" and "resistance to fracture", in conjunction with logical Boolean operators OR y AND.

3. Results and Discussion

3.1 Degree of Conformation

The design of a contracted endodontic cavity (CEC) preserves more dentin but may influence the geometric shaping parameters [8]; it is important to know the clinical factors that determine the prognosis so that the correct intervention [9] is chosen in order to obtain the same quality and treatment results [10]. Studies show that the location and design of the endodontic access cavity did not affect root canal preparation [4] in upper molars [11] or premolars [12] tested in vitro. However, instrumentation efficiency became higher in maxillary central incisors in the lingual incisal straight-line access [13] being a CEC. A CEC offered no advantage [14] although it did make the pulp chamber cleaning procedure more difficult, increasing the total time required [15], when debated against TECs [16]. TEC showed greater preservation of the original root canal anatomy with less apical transport, possibly due to the absence of coronal interference, and therefore less insertion movements are required to complete instrumentation [8].

No real compromise in the degree of canal conformation is demonstrated, although neither is there a benefit, when performing CEC. The instrument achieves similar contact areas on the canal walls, even larger in maxillary central teeth, without compromising the treatment; the longer time spent in this type of access is left to be considered.

3.2 Degree of Disinfection

Irrigation has several key functions, the most important of which are to dissolve tissues and to have an antimicrobial effect [17]. Most studies highlight E. faecalis as the main pathogen responsible for endodontic treatment failure, having mechanisms to survive in different environments, for example, its ability to resist different disinfection measures [18]. Intra-canal medication, with instrumentation and irrigation, efficiently eliminates E. faecalis from infected root canals [19]. In a study where all initial samples were positive for E. faecalis; after preparation, the number of positive samples was significantly higher in the CEC group (86%) than in the TEC group (50%). Disinfection was significantly compromised after root canal preparation of teeth with CEC [20]. In contrast, in another study, the number of E. faecalis bacteria in all samples with different cavity designs was significantly reduced after instrumentation. Bacterial reduction counts of E. faecalis were of a similar level in TEC and CEC cavities [21], revealing no significant variations in microbial reduction between groups [22]. CECs appear to satisfy the principles of minimally invasive endodontics (MIE) by preserving natural dentin, but new endodontic irrigation strategies are required [23]. Er:YAG laser irradiation at 1.0 W for 20 seconds can be considered a promising procedure for MIE [24]. In recent years, a multisonic GentleWave system has been introduced to facilitate the cleaning of minimally instrumented canals or even non-instrumented canals [25].

In view of the different results obtained, it is not possible to reach an adequate conclusion on the degree of disinfection in a CEC; priority should be given to a TEC, ensuring the treatment outcome.

3.3 Filling ability

Root canal obturation is performed as the final and most important procedure of root canal treatment. The 3D filling is the key determinant of endodontic success [26]. The percentage of root filling material did not differ significantly between CEC and TEC in premolars [12] and therefore did not influence the quality of root filling [15]. In another study, the small dimensions of the minimally invasive access made it difficult to adapt the gutta-percha cone when using the single cone technique and hindered the performance of the continuous wave condensation method [27]. Likewise, they were associated with significantly more voids in the root canal filling [4] as well as a larger volume of remaining filling material inside the pulp chamber [28] in mandibular molars [22]. For these reasons, it was concluded that thermal lateral compaction is the best option for canal filling in teeth with minimally invasive access preparations [27].

Efficient canal obturation in a CEC is limited to a single obturation technique. If it is not intended to work under this protocol, the use of a TEC is suggested, facilitating obturation and control of the material.

3.4 Fracture Resistance

Authors conclude that, tooth life is more affected by the design of the access cavity than by the different tapers of the prepared canals [29], because stress patterns migrate apically rather than concentrating in the pericervical area. Crack initiation and propagation can occur anywhere on the root surface [30]. Under review, it is found that, CECs preserving the integrity of the marginal ridge did not affect fracture resistance [31]. Endodontically treated teeth showed a biomechanical behavior similar to that of healthy teeth [32]. Equivalent results are shared in another study, where the endodontic cavity did not influence the biomechanical behavior of teeth restored [33] with the same composite base material [34]. CECs offered no advantage compared to TECs in the fracture resistance of endodontically treated mandibular molars [14] or 2-rooted maxillary premolars [12, 15]. In contrast, the least effective fracture resistance in maxillary centrals was obtained in the lingual incisal straight-line access group [13]. This systematic review of in vitro studies showed that there is no evidence to support the use of CEC over TEC for increased fracture resistance in human teeth [35]. There is insufficient evidence to make a final decision in terms of fracture resistance and more studies are needed on this topic [6].

Under a logical concept it is assumed that by preserving more coronal tooth structure, the risk of fracture will decrease. The

research does not demonstrate a notable change in fracture resistance in a CEC over a TEC; it has been pointed out that preservation of the marginal ridge decreases the risk of fracture, therefore, the coronal anatomical structures involved during access should be considered in future research.

4. Conclusions

The success of endodontic treatment is represented by each of the stages that make up the procedure. CECs are an alteration to the traditional protocol and with it to the rest of the treatment stages, where: shaping is not perceived as a superior benefit, the degree of disinfection does not improve, and the obturation is not guaranteed an adequate sealing of the canal. The concern about TEC and the risk of fracture should cease to be considered a problem; there is no greater risk in this type of endodontic access; greater clinical support is required for CEC, which would allow them to be considered an option in the protocol.

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