

# Foraminal enlargement: Local and systemic repercussions

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## ABSTRACT

**Introduction:** endodontic infection can reach and even go beyond the apical foramen. Therefore, determining apical constriction as the ideal limit for instrumentation and obturation has been questioned. Intentional foraminal enlargement is performed for the purpose of reducing the microbial contingent to levels more favorable to repair. However, local and systemic repercussions have been associated with this approach. **Objectives:** to critically review the literature on local and systemic repercussions relative to intentional foraminal enlargement. **Methods:** in March 2018, an electronic search performed on the PUBMED database using the terms “foraminal enlargement” OR “foraminal widening” OR “apical limit” AND “endodontics” identified 74 scientific articles. These articles, analysis of their references and use of another 5 base articles resulted in the 115 studies used for performing this research. **Results:** intentional foraminal

enlargement cannot always be performed due to the anatomical and morphological conditions. The greater the apical foramen enlargement, the greater the possibility of extrusion of substances and/or materials used to perform endodontic treatment. Intentional foraminal enlargement seems to be contraindicated in patients who are taking or have recently used bisphosphonates, those with coagulation disorders and/or under chronic use of anticoagulants and at high risk for bacteremia. **Conclusions:** the impacts of intentional foraminal enlargement on the success of endodontic treatment should be investigated. However, the methodological procedures of clinical studies should be carefully designed, especially taking into consideration the systemic conditions of patients who will be part of the sample.

**Keywords:** apical foramen; foraminal enlargement; endodontic treatment.

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## Introduction

Endodontics is one of the specialties that has undergone the largest number of changes in the way treatment is performed by virtue of the technical-scientific developments that have taken place over the last few decades.<sup>1-6</sup> Nevertheless, the binomial “cleaning and shaping”<sup>7</sup> continues to be one of its fundamental bases, especially in cases of infection.

Due to the anatomic complexity of the root canal system, the literature has shown difficulties with obtaining an adequate process of cleaning and disinfection, particularly in the apical third.<sup>8</sup> Moreover, endodontic infection may be localized in areas beyond the apical constriction; that is, in the foramen and external apical root surface (extraradicular biofilm).<sup>9-11</sup>

Extraradicular biofilms are only eliminated by means of paraendodontic surgeries.<sup>12,13</sup> To control the infection present in the region of the apical foramen, foraminal patency is recommended.<sup>14,15</sup> This procedure consists of the use of a fine caliber instrument that softly touches the walls of the foramen.<sup>14,15</sup> This avoids the accumulation of dentin, loss of working length, apical deviations, perforations and excessive extrusion of debris.<sup>16</sup> Furthermore, it potentiates the disinfection process by transporting the auxiliary chemical substance up to the final millimeters of the root canal.<sup>14,15,17,18</sup> However, foraminal patency does not promote mechanical cleaning of the apical foramen.<sup>19,20</sup>

Instrumentation or intentional foraminal enlargement is based on the use of instruments with larger calibrations at the level of, or slightly beyond the real working length of the tooth.<sup>21,22</sup> The purpose of this is to diminish the microbial contingent to levels that are even more favorable to repair by means of mechanically cleaning the foraminal walls.<sup>21,23</sup> Previous studies have demonstrated satisfactory results of this treatment philosophy.<sup>24-27</sup> However, local and systemic repercussions have been associated with intentional foraminal enlargement.<sup>28-30</sup>

The aim of this article was to make a critical analysis of the literature about local and systemic repercussions related to intentional foraminal enlargement.

## Materials and methods

In March 2018, an electronic search, without limit on dates was conducted in the PUBMED database, using the terms “foraminal enlargement” OR “forami-

nal widening” OR “apical limit” AND “endodontics”. This resulted in 74 scientific articles being identified. These articles, analysis of their bibliographic references and the use of another 5 complementary studies,<sup>28-32</sup> resulted in the 115 studies consulted for conducting this research.

## Local repercussions associated with intentional foraminal enlargement

### *Anatomic considerations*

Clinical studies have demonstrated a higher incidence of endodontic instrument fractures in the apical third.<sup>33,34</sup> Considering that posterior teeth are the type that mainly have apical foramen localized laterally to the root apex, intentional foraminal enlargement, in these cases, predisposes these teeth to even higher risks for the occurrence of this accident, by virtue of the different directions of the root canal before and after apical constriction.<sup>35-36</sup>

Furthermore, the apical foramen shape and characteristics of the endodontic instruments constitute limitations to intentional foraminal enlargement. In the majority of cases, the apical foramen is oval-shaped.<sup>37,38</sup> To enable conventional endodontic instruments to effectively touch their walls, it is necessary to use larger caliber instruments,<sup>39,40</sup> which predisposes the teeth to developing microcracks or apical fractures.<sup>41</sup> Even so, the chances of these instruments touching the foramen walls is highly unlikely.<sup>42</sup>

Another limiting factor to intentional foraminal enlargement is the impossibility of obtaining the apical patency.<sup>43</sup> This occurs due to the presence of abrupt curvatures, two or more main apical foramina, apical deltas and complete or incomplete isthmuses.<sup>44</sup>

Although intentional foraminal enlargement would be a reasonable idea from the microbiological point of view, it is not always possible to perform it, considering the anatomic complexity of root canal systems.<sup>43</sup>

### *Extrusion of substances and materials into the periradicular tissues*

Sodium hypochlorite is the irrigant most frequently used in Endodontics.<sup>45-53</sup> However, it is highly aggressive when it extravasates to regions beyond the apical foramen.<sup>54-59</sup> The most common consequences of this accident are: severe pain, immediate inflammation of the affected area, extension of edema

to the face, lips and infra-orbital region, interstitial hemorrhage and that arising from the root canal, with echymosis of the skin and mucosa, secondary infection and paresthesia.<sup>54-60</sup>

Another frequently used drug with reports of extrusion with negative consequence is calcium hydroxide.<sup>61-63</sup> Fava, in 1993<sup>61</sup> and Marais & Van der Vyver, in 1996,<sup>62</sup> reported cases of calcium hydroxide extrusion into the maxillary sinus, causing acute pain and foreign body reaction. Ahlgren et al., in 2003,<sup>63</sup> reported a case of calcium hydroxide extrusion into the mandibular canal with acute pain and paresthesia. Neural lesions,<sup>64</sup> severe periradicular inflammation and need to extract the tooth involved,<sup>65</sup> in addition to the persistence of periradicular lesions have also been associated with the extrusion of this substance.<sup>66</sup>

Filling materials (mainly solids) are also responsible for complications when they are overfilled to regions beyond the apical foramen. Inferior alveolar nerve damage, development of periradicular lesions of the foreign body type and flare-ups have also been associated with this occurrence.<sup>67-72</sup>

There are no scientific evidences demonstrating benefits relative to the extrusion of any substance or materials into the periradicular tissues.<sup>56-58,73-77</sup> The greater the apical foramen enlargement, the greater the chances of extrusion.<sup>78</sup>

### **Systemic repercussions associated with intentional foraminal enlargement**

#### *Patients who make use or have recently made use of bisphosphonates*

Bisphosphonates are medications used in the treatment of bone diseases and in the prevention of tumor metastases.<sup>79</sup> Their chronic use has been associated with osteonecrosis of the maxillae after dental procedures.<sup>79-82</sup> Therefore, dentists must take care to minimize or neutralize the potential negative effects related to the use of these drugs:

» Before the intervention, antiseptic substances such as chlorhexidine reduce the bacterial load in the oral cavity<sup>83</sup> and the risks of bacteremia by virtue of possible damage to the soft tissues.<sup>30,84</sup>

» As bisphosphonates have angiogenic action, anesthetics with vasoconstrictors must be avoided due to the possibility of the patient's vascularization being compromised.<sup>30,85</sup>

» Bisphosphonates interfere directly in the bone remodeling process and in the inhibition of chemical mediators of the inflammatory process.<sup>86,87</sup> Therefore, apical limits of instrumentation must be established at the apical constriction or as closely as possible to this area, with the purpose of preventing the extrusion of debris and exacerbated inflammatory reactions during and after treatment.<sup>86,87</sup> The apical patency itself must be avoided by virtue of the risks of bacteremia.<sup>28,30</sup> Furthermore, priority must be given to performing obturation techniques that offer less possibility of over-filling and over-extension.<sup>30</sup>

#### *Patients with coagulation disorders or those using anticoagulant medications*

In healthy patients, hemostasis is associated with 4 main factors: blood vessel walls, platelets, coagulation and fibrinolytic systems. Constriction of the blood vessels constitutes the first stage in this process, followed by platelet adhesion and aggregation, and deposition of fibrin. Coagulation, a continuous act, is guided by physiological agents. Fibrinolysis is triggered by the presence of fibrin and plasminogen activators. It is regulated by the action of physiological inhibitors, such as: antiplasmin-2, histidin-rich glycoprotein and plasminogen activator inhibitor.<sup>32,88-91</sup>

In patients with coagulation disorders or who make chronic use of anticoagulant agents, this process is changed, resulting in excessive bleeding, even when subjected to small stimuli. Dentists must consider the impact of blood disorders and/or chronic use of anticoagulant agents to enable them to correctly delineate the planning of each intervention.<sup>31,92,93</sup> In the event of the need for endodontic treatment, intentional foraminal enlargement appears to be contra-indicated.<sup>94</sup>

#### *Patients at high risk for bacteremia*

Various systemic complications such as bacterial endocarditis, acute infarction of the myocardium, cerebral abscess, bone, antral and blood infections have been associated with odontogenic infections.<sup>95-101</sup>

During endodontic treatment, extrusion of bacteria into the bloodstream and lymphatic system may occur.<sup>100,102-104</sup> This has been proved by the existence of similar microbiological profiles in the root canals and bloodstream of the same patients.<sup>105-108</sup> According to Tinaz et al., in 2005,<sup>109</sup> a larger quantity of debris extrusion occurred after intentional foraminal enlargement.

## Conclusions

The choice of the apical limit of instrumentation should invariably be based on scientific evidences. Up to now, no randomized clinical study with longitudinal follow-up has been conducted and published, demonstrating the success rates of endodontic treatments or retreatments after foraminal enlargement. Whereas, controlled clinical studies with robust samples and adequate inclusion and exclusion criteria have revealed high success rates when the apical limits of instrumentation were established closed to the apical constriction.<sup>110-112</sup> Therefore, according to the principles that guide clinical

practice based on scientific evidences, the ideal apical limit for instrumentation is the apical constriction.

The impact of intentional foraminal enlargement on the success of endodontic treatment must be investigated. There is biological plausibility associated with this clinical strategy. However, the methodological designs of future studies must be made carefully, particularly with reference to the systemic conditions of patients who will form part of the sample universe. Those who make use, or who made recent use of bisphosphonates and anticoagulant agents, with high risk for bacteremia, and those with blood disorders must promptly be excluded from the samples.

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