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The Importance of Apical Patency and Cleaning of the Apical Foramen on Root Canal Preparation

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The apical limit of root canal instrumentation has always been a matter of great controversy. Despite the large number of published studies on this subject, a consensus has not yet been reached. In fact, the recent discussion on apical patency and cleaning of the apical foramen, as well as the incorporation of these procedures to the endodontic treatment, seem to have raised even more polemics. It is likely that all this polemics has its roots in the lack of interrelation between the theoretical knowledge of pulp stump and periapical tissues and the real clinical practice. By addressing the most important aspects of this theme, this paper aims to present news concepts about the importance of apical patency and cleaning of the apical foramen during root canal preparation.

Key Words: root canal therapy, apical limit, apical patency, cleaning of the apical foramen.

INTRODUCTION

The apical limit of root canal instrumentation is still a very controversial topic in Endodontics (1,2). The possibility of aggressions to apical and periapical tissues has supported the principle of the working length staying short of the radiographic apex (3-6).

Although some authors still advocate that it is possible to establish, by tactile sensibility, the CDJ (cementodentinal junction) limit as the ideal point where root canal preparation should end, it has been demonstrated that this procedure leads to several errors (7). Different working lengths have been proposed, but the most widely accepted approach seems to be choosing a working length of 1 mm coronal to the root apex. According to these concepts, the cemental canal should not be instrumented (3-5).

Currently, the role of microorganisms in pulpal and periapical diseases is well known, and the anaerobic bacteria are recognized as important pathogens. Despite the divergences concerning their percentage, the predominance of anaerobic microorganisms in the apical third, including the cemental canal, is a common trait in most studies (8,9). This understanding has brought about important changes for endodontic therapy. Some authors have supported the idea that the cemental canal should be included in root canal instrumentation, which means that, in many cases, the endodontic treatment should not be limited to a point located 1 mm short of the root apex, but should instead be extended to the full canal length (10,11). Although there is a recent trend to accept this approach in some cases of teeth with periapical lesion, in fact, the apical limit of instrumentation in teeth with necrotic and vital pulps is still a source of discussion and controversy in the several areas of Endodontics.

In cases of periapical lesion, recognizing the presence of microorganisms in the cemental canal (8), and even in the lesion itself (9), has contributed to spread the acceptation of cleaning and debridement of the

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apical foramen during root canal instrumentation. Nevertheless, the possible existence of a vital pulp stump in cases of necrotic pulp without periapical lesion has precluded the full acceptation of these procedures by endodontists and researchers.

On the other hand, the major concern during root canal therapy of teeth with vital pulp has been to preserve the vitality of the pulp stump. For this reason, several authors have recommended that the working length should be determined 1-2 mm short of the radiographic root apex (3-5).

Addressing the many issues related to this topic is the scope of this paper.

DISCUSSION

The literature has referred to apical patency with certain frequency (1,3-5,10-14) and occasionally to cleaning of the apical foramen (10,11). Because the definitions of these procedures are often misunderstood, it is essential to address the differences between them, before any discussion is undertaken.

During root canal preparation, dentin chips produced by instrumentation and fragments of apical pulp tissue tend to be compacted into the foramen, which may cause apical blockage and interfere with the working length. The repeated penetration of the apical foramen with a file of adequate size during instrumentation prevents the accumulation of debris in this area leaving the foramen unblocked, i.e., patent. This concept has been defined as apical foramen patency (11-15). Therefore, establishing apical patency is leaving the apical foramen accessible, free from dentin chips, pulp fragments and other debris. Some authors have suggested that apical patency should be gained with an instrument that binds to the foramen, i.e., if the foramen has a diameter of 0.20 mm, a #20 file should move passively through the foramen without advancing beyond the terminus of the root canal.

However, one of the arguments against this procedure is that a file that binds to the foramen will act like an embolus, increasing the possibility that debris are inadvertently extruded beyond the apex. On the other hand, the use of a file that is not adjusted to the apical portion will offer a lesser risk of extrusion of debris or, at least, minimize its occurrence (11). Considering that the purpose of this procedure is to prevent the accumulation of dentin chips in the apical area, the use of an instrument of smaller size than the foramen will be effective with the advantage of offering a lesser risk of displacement of toxic products and dentin fragments from the root canal into the periapical space. The patency file should preferably be two sizes smaller than the instrument that binds to the foramen (11).

In a root canal with pulpal necrosis and periapical lesion, it is known that the cemental canal is full of bacteria, particularly anaerobic, and apical patency allows maintaining the access to this portion of the canal. Nevertheless, it must be taken into account that the maintenance of apical patency does not clean the foramen; it only avoids apical blockage by entrapment of dentin chips. The apical foramen should be instrumented to be actually cleaned (11). In other words, a patent foramen is not necessarily clean because apical patency and apical cleaning are two different procedures.

In cases of necrotic pulp without periapical lesion, terminating instrumentation at a point located coronal to the root apex leaves a portion of the apical third uninstrumented, and this extension varies from author to author. The most commonly accepted working length is 1 mm short of the apex, which means that 1 mm of the root canal will not be instrumented and thus will not be cleaned. According to Cohen and Burns (16), 1 mm of a canal with a diameter of 0.25 mm, which is the diameter of narrower foramens (7), provides enough space to lodge nearly 80,000 streptococci.

The presence of bacteria in the cemental canal has been strongly demonstrated in cases of necrotic pulps with periapical lesion (8). In addition, several studies have shown the presence of bacteria within the lesion itself (9). Therefore, from a biological standpoint, it does not seem acceptable to preclude the instrumentation of this portion of the canal.

Apical patency is established during root canal preparation with the purpose of maintaining access to the foramen (mechanical goal), but it is important that after instrumentation the foramen is not only patent but also clean (biological goal). A patency file, which should have a smaller diameter than the foramen, will probably not do this cleaning properly. The use of an instrument that binds to the foramen and touches all root canal walls will certainly be more indicated. Therefore, the best approach would be to ensure apical patency with a file of smaller diameter during instrumentation and then clean the foramen with a file that binds to its walls.

Some authors advocate that mechanical cleaning of the foramen is unnecessary because they believe that irrigating solutions and intracanal dressings are able to do so. Nevertheless, the literature has shown that, in spite of all efforts, dentin chips are inadvertently compacted into the apical portion of the canal during instrumentation and form a dentin plug (17). Therefore, it seems likely that, in some situations, the effectiveness of these chemical agents is reduced or even neutralized (11). The dentin plug acts as a mechanical barrier that precludes, or at least interferes with, the contact of the irrigating solutions and intracanal medications with the cemental canal walls. Moreover, due to the restrictions that some authors have made about sodium hypochlorite contacting the periapical tissues, intracanal irrigation has been done in such a way to avoid reaching this portion of the canal. The presence of a periapical bacterial biofilm poses an additional difficulty to the cleaning process and the elimination of microorganisms from this area exclusively by chemical action is even less likely. Furthermore, it is a surgical axiom that mechanical cleaning should always precede chemical cleaning or at least both should occur concomitantly.

It seems clear that there are two major goals concerning cemental canal instrumentation. The first, apical patency, is mechanical, and is intended to maintain the working length. The second, apical cleaning, is biological, and is intended to eliminate the infection established in the cemental canal. The second goal is achieved through the first. Therefore, from a biological standpoint, it is recommendable that, in cases of pulp necrosis (with or without periapical lesion), both patency and cleaning of the apical foramen are performed.

However, an extremely important issue should not be overlooked while discussing this topic. If the working length is established close to the CDJ limit, the instrument chosen as the binding file will actually adjust to the point known by some as the "minor foramen". This is the point where the apical constriction is supposedly located, considering that the dentinal canal converges towards the apex. From this point on, the cemental canal presents divergent walls. This means that the binding file will bind solely to a portion of the foramen and will not touch the divergent walls of the cemental canal, thus limiting its cleaning potential. This might explain why, even after the foramen is cleaned, some cases do not respond to the endodontic treatment and the associated periapical lesion persists. In these situations, the foramen should be actively cleaned, i.e., in addition to the binding file, one or two files of greater size should be used for apical debridement and optimal instrumentation of the intracanal walls in this region. As the literature has shown the presence of bacteria beyond the foramen, this instrumentation should be extended 1 to 2 mm beyond this area (11).

Another question is raised: how should the endodontist proceed in cases of root canal treatment of teeth with vital pulp? In conditions of pulp vitality, there is no infection in the dentinal canal and even less in the cemental canal. Therefore, from a biological point of view, there is no need for disinfection procedures, which means that the use of the expression "cleaning of the apical foramen" is not justified. Even though, some authors have advocated that the vital pulp stump should be extirpated because, being the least cellularized portion of the pulp tissue, it does not have healing potential and might become necrotic after root canal preparation and obturation. According to these authors, the vital pulp stump should be extirpated with the binding file.

However, in the same way as the need of using four to five files for root canal enlargement and pulp tissue extirpation, it seems unlikely that the pulp stump can be completely removed with a single instrument. The action of a single file would much more lacerate than remove the pulp stump. In addition, the action of some instruments during this procedure may induce postoperative pain. Cleaning of the foramen in canals with necrotic pulp is intended to create the conditions for healing and formation of a new pulp stump. However, since there is no need for disinfection of this portion in teeth with vital pulps, the removal of a healthy tissue for replacement by another tissue in the same conditions does not seem justifiable or add any benefits.

Regrettably, loss of the working length still is a common adverse event during endodontic therapy, especially among less experienced clinicians, and its major cause is the formation of an apical dentin plug (11,18). Therefore, establishing apical patency is recommendable even during treatment of canals with vital pulps. In view of this, two aspects should be addressed.

First, although the term "pulp stump" is renowned and widespread, it is completely inadequate and leads to equivocated interpretations. Terminating the endodontic preparation 1 mm short of the root apex implies assuming that practically the entire tissue (or actually the entire

tissue) contained in this portion of the canal is periodontal. This is a connective tissue with great healing potential and high turnover. Even if removed, it is able to reconstitute itself. Secondly, it should be understood that apical patency does not provide removal of the pulp stump (11). This idea is also equivocated. Neither the use of an instrument that binds to the foramen nor its manipulation is recommended for removal of the pulp stump. Those who do so misunderstand this issue and perform it erroneously. Apical patency is intended exclusively to prevent that dentin chips are compacted into the apical region forming a plug that can interfere with the working length. In canals with necrotic pulp tissues, apical patency is ensured with instruments that do not bind to the foramen to prevent the displacement of necrotic material from the canal into the periapical space. In canals with vital pulps apical patency should always be established with extremely thin instruments to minimize the trauma induced to the apical tissues.

It may be argued that apical patency is an unnecessary procedure for root canal therapy of teeth with vital pulps by experienced endodontists or when nickel-titanium rotary instrumentation is used. As apical patency is intended to minimize the occurrence of apical blockage and loss of working length, it would be dispensable in any situation where such risks are not present. Nevertheless, it does not seem to be the reality of a considerable part of the professionals performing endodontic treatment.

RESUMO

O limite apical de trabalho sempre constituiu um tema de muita controvérsia. Apesar dos vários trabalhos que já foram publicados sobre o assunto, ainda não existe uma definição sobre ele. A recente discussão sobre patência apical e limpeza do forame e a incorporação desses procedimentos ao tratamento endodôntico parece ter gerado uma polêmica maior ainda. É possível que essa polêmica tenha a sua causa maior na ausência de interrelação do conhecimento que se tem sobre o coto pulpar e tecidos periapicais e a realidade dos fatos da clínica. Através de uma discussão sobre os principais aspectos desse tema, este artigo pretende apresentar uma nova concepção a respeito da importância da patência apical e limpeza do forame no preparo do canal.

REFERENCES

1. Cailleteau JG, Mullaney TP. Prevalence of teaching apical patency and various instrumentation and obturation techniques in United States dental schools. J Endod 1997;23:394-396.
2. Negishi J, Kawanami M, Ogami E. Risk analysis of failure of root canal treatment for teeth with inaccessible apical constriction. J Dent 2005;33:399-404.
3. Holland R, Sant'anna Júnior A, Souza V, Dezan Junior E, Otoboni Filho JA, Bernabé PFE, Nery MJ, Murata SS. Influence of apical patency and filling material on healing process of dogs' teeth with vital pulp after root canal therapy. Braz Dent J 2005;16:9-16.
4. Ricucci D. Apical limit of root canal instrumentation and obturation, part 1. Literature review. Int Endod J 1998;31:384-393.
5. Ricucci D, Langeland K. Apical limit of root canal instrumentation and obturation, part 2. A histological study. Int Endod J 1998;31:394-409.
6. Schaeffer MA, White RR, Walton RE. Determining the optimal obturation length: a meta-analysis of literature. J Endod 2005;31:271-274.
7. Vanni JR, Santos R, Limongi O, Guerisoli DMZ, Capelli A, Pécora JD. Influence of cervical preflaring on determination of apical file size in maxillary molars: SEM analysis. Braz Dent J 2005;16:181-186.
8. Baumgartner JC, Falkler WA. Bacteria in the apical 5 mm of infected root canals. J Endod 1991;17:380-383.
9. Wayman BE, Murata SM, Almeida RJ, Fowler CB. A bacteriological and histological evaluation of 58 periapical lesions. J Endod 1992;18:152-155.
10. Souza, RA. Clinical and radiographic evaluation of the relation between the apical limit of root canal filling and success in Endodontics. Part 1. Braz Endod J 1998;3:43-48.
11. Souza, RA. Endodontia Clínica. São Paulo: Santos; 2003.
12. Goldberg F, Massone EJ. Patency file and apical transportation: an *in vitro* study. J Endod 2002;28:510-511.
13. Izu KH, Thomas SJ, Zhang P, Izu AE, Michalek S. Effectiveness of sodium hypochlorite in preventing inoculation of periapical tissues with contaminated patency files. J Endod 2004;30:92-94.
14. Cemal-Tinaz A, Alacam T, Uzun O, Maden M, Kayaoglu G. The effect of disruption of apical constriction on periapical extrusion. J Endod 2005;31:533-535.
15. Buchanan S. Management of the curved root canal. J Calif Dent Assoc 1989;17:18-27.
16. Cohen S, Burns RC. Pathways of the pulp. 6th ed. St. Louis: Mosby; 1994.
17. Beeson TJ, Hartwell GR, Thornton JD, Gunsolley JC. Comparison of debris extruded apically in straight canals: conventional filing versus profile .04 taper series 29. J Endod 1998;24:18-22.
18. AL-Omari MAO, Dummer PM. Canal blockage and debris extrusion with eight preparation techniques. J Endod 1995;21:154-158.

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