Archives of Veterinary Science **ISSN 1517-784X**
v.23, n.1, p.01-08, 2018 www.ser.ufpr.br/veterinary

EVALUATION OF CANINE ROOT CANAL THERAPY USING PROTAPER® SYSTEM

*(*Avaliação da terapia de canal radicular canina utilizando o sistema Protaper®)

Dorie Fernanda Zattoni[1*], Frederico Guilherme Freitas Lobão Rodrigues Gomes[1], João Armando Brancher[2], Djanira Aparecida da Luz Veronez[1], Ana Tereza Bittencourt Guimarães[3], Maria Fernanda Torres[1]

[1] Universidade Federal do Paraná, Curitiba, Paraná, Brasil, [2] Universidade Positivo, Curitiba, Paraná, Brasil, [3] Universidade Estadual do Oeste do Paraná, Cascavel, Paraná, Brasil.
*Corresponding author: doriezattoni@gmail.com

ABSTRACT: Industry data for pet products has revealed that most Brazilian families have pets in their homes and that that humans give a large amount of attention to their pets. Oral diseases are among the most quickly perceived and treated of pet pathologies; and the most common of these is periodontal disease, which can affect the pulp and requires endodontic treatment. Recently, the development of superelastic nickel-titanium alloys has revolutionized endodontic therapy, as the alloys have been used to develop novel rotary instruments. The goal of this study was to evaluate the efficiency of such rotary instruments in the ex vivo shaping of canine dental root canal therapy. The sample consisted of 40 canine incisors that had been extracted due to periodontal disease. The endodontic access procedure was performed, and the root canal was prepared using ProTaper® rotary instruments. Before and after shaping the canals, teeth were examined radiographically. The cervical, middle, and apical thirds were analyzed using the Image Lab® program. Results showed that the ProTaper® rotary instruments removed significant amounts of dentine (cervical third: $T=-13.225$, $p<0.0001$; middle third: $W=410$, $p<0.0001$; apical third: $W=410$, $p<0.0001$). Regarding shaping of the canal, the apical third had expanded significantly, and there was a positive correlation between measurements in all analyzed thirds (cervical third: $r=0.924$; middle third: $r=0.980$; apical third: $r=0.993$.) This demonstrates an increase in the surface area of the channels in all three thirds. In this study, we conclude that the rotary instruments used were efficient in shaping root canals.
Keywords: Endodontics, rotary instruments, root canal

RESUMO: Dados da indústria de produtos para animais de estimação revelam que a maior parte das famílias brasileiras possuem pets em suas casas. Consequentemente, a atenção humana dispensada aos pets aumentou. Doenças bucais são rapidamente percebidas e tratadas. A doença bucal mais frequente é a doença periodontal que pode afetar a polpa dentária e resulta no tratamento endodôntico. Recentemente o desenvolvimento de ligas de níquel titânio revolucionaram a terapia endodôntica, uma vez que a superelasticidade dessas ligas foram aplicadas para o desenvolvimento de instrumentos rotatórios. O objetivo deste estudo foi avaliar a eficiência de instrumentos endodônticos rotatórios na modelagem laboratorial de canais radiculares de dentes de cães. A amostra foi composta de 40 dentes incisivos e caninos de cães extraídos devido à doença periodontal. Foi realizado o acesso endodôntico e os canais radiculares foram preparados com instrumentos rotatórios ProTaper®. Antes e após a modelagem dos canais, os dentes foram submetidos a exame radiográfico e os terços cervical,

Recebido em 11/06/2015
Aprovado em 13/12/2017

médio e apical foram analisados pelo programa Image Lab®. Os resultados obtidos para a área de superfície mostraram que os instrumentos rotatórios ProTaper® removeram quantidades significativas de dentina (terço cervical t= 13,225; p<0,0001; terço médio W=410; p<0,0001 e terço apical W=410; p<0,0001). No que diz respeito à modelagem dos dentes, os resultados revelaram que a expansão do terço apical foi significante e que houve uma correlação positiva entre as medidas em todos os terços analisados (r= 0,924 no terço cervical; r= 0,980 no terço médio e r= 0,993 no terço apical) denotando um aumento homogêneo na área dos canais. Neste estudo, presumimos que os instrumentos rotatórios utilizados foram eficientes para modelar os canais radiculares.
Palavras-chave: Endodontia, instrumentos rotatórios, canais radiculares.

INTRODUCTION

In Brazil, pets are a very important part of people's lives. Indeed, industry data for pet products has revealed that most Brazilian families have pets in their homes (ABINPET, 2013), and that there has been an increase in both the attention given to pets and in the perception of their needs. Dermal and oral diseases are among the most quickly perceived of pet pathologies, and owners promptly seek care for these conditions.

Oral diseases in particular are very common in dogs. For instance, a study from the United States found that 93% of dogs there had dental diseases of varying degrees of severity (Lund et al., 1999). These results are similar to those of a European study by Kyllar and Witter (2005). In Brazil, the situation is similar. For example, Fecchio et al. (2009) showed that almost 90% of dogs treated at a university veterinary hospital presented with oral diseases to some degree.

The most common diseases observed in these pets are dental calculus, missing teeth, abnormal attrition, tumors, resorptive lesions, dental trauma, and periodontal disease, which is the most prevalent of the oral diseases (Hoffman & Gaengler, 1996; Lund et al., 1999; Pihlstrom, 2005; Helieh & Puleo, 2011). The higher prevalence of periodontal disease can be explained by the fact that a bacterial biofilm accumulates on the tooth surface as a result of inadequate oral hygiene (Holt & Ebersole, 2005). These bacteria cause gingival inflammation, which affects the tooth-supporting tissue and leads to periodontal disease (Waddington et al., 2000). Furthermore, it is important to note at this point that distant organs are also affected by such pathologies, not only the oral cavity (Debowes et al., 1996). Therefore, in both humans and animals, there is a strong association between oral and systemic diseases.

Pulp changes resulting from periodontal disease are common. Such changes may be irreversible and result in tooth loss. Moreover, diagnosing and treating patients affected by pulp diseases is a challenge for the veterinarian. The treatment is lengthy and expensive, and is most often performed under general anesthesia, which causes stress to the patient. Therapeutic success demands that care be taken at every step of the treatment, but the biggest challenge is the shaping and cleansing of the root canal, as their internal anatomy is complex and variable (Tutt, 2007). Often, each root does not possess a single channel, but rather a complex of channels and side canaliculi. Each of these must be cleansed properly to eliminate bacteria, bacterial metabolic byproducts, contaminated dentine, and irritants. Shaping of the canals must be performed using hand tools such as files that allow the practitioner to obtain a tapered shape. Consequently, this stage of treatment is very time-consuming.

Recently, the development of superelastic nickel-titanium (Ni-Ti) alloys has revolutionized endodontic therapy, as the alloys have been used to develop both hand and rotary instruments. This has significantly reduced surgical time. In this study, our goal was to evaluate the efficiency of rotary instruments in the ex vivo shaping of canine root canals.

MATERIAL AND METHODS

The sample consisted of 40 canine mandibular central incisors and canines that had been extracted due to periodontal disease. The mean length of the teeth was 21.0 mm, and radiography confirmed a single root

canal in each case. Specifically, the canal was observed on a mesiodistal radiograph by using a size 15 K-file. Additionally, the teeth had fully formed roots and apical foramina with diameters corresponding to that of a size 15 K-file. Indeed, teeth that did not match these criteria were excluded from the study. The teeth were stored in 0.1% thymol solution at 4°C before use.

Endodontic tissue was accessed using a drill number 1014, and the root canal was explored using a size 10 K-file (Dentsply/Maillefer; Ballaigues, Switzerland). The working length was established by subtraction of 1.0 mm from the measurement established during this exploration. All root canals were prepared using ProTaper® Ni-Ti files (Dentsply/Maillefer). The cervical and middle thirds of all specimens were prepared using SX instruments (D0 = 0.19 mm; 3.5% taper). At the working length ([apical root] - 1 mm), we used the S1 (D0 = 0.18 mm, 2% taper) and S2 (D0 = 0.20 mm, 4% taper). We also employed the F1 (D0 = 0.20 mm; 7% taper over the first mm) and, if necessary, the F2 (D0 = 0.25 mm; 8% taper over the first mm).

The canals were irrigated with sodium hypochlorite (5 mL, 2.5%) after each procedure using the Ultradent® irrigation kit; NaviTip® #20; 5 mm short of the working length. The solution remained in the canal for 30 s during each subsequent filing procedure. After the procedure was complete, all samples were irrigated with EDTA solution (5 mL; Figure 1).

After preparation, mesiodistal radiography was once again performed, and the initial and final images were analyzed using the Image Lab® program. Measurements were taken of the cervical, middle, and apical thirds both before and after shaping of the root canals. The distribution pattern of the values in each third was assessed using the Shapiro-Wilk test.

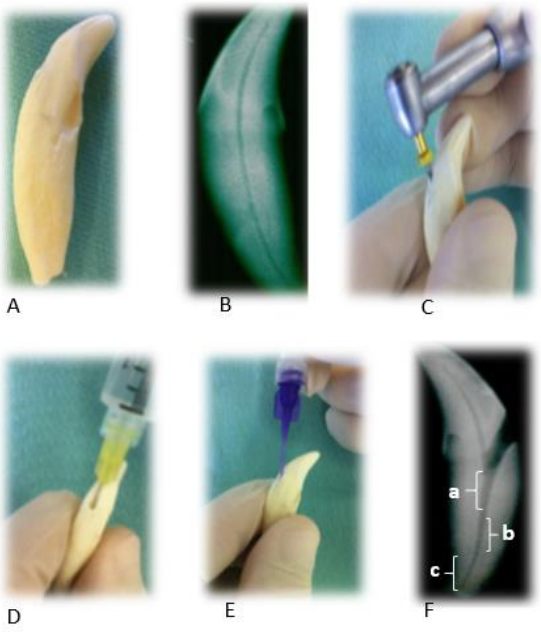

Figure 1 Operative sequence. A) Initial image from canine tooth, B) mesiodistal initial radiography, C) shaping of the root canal, D) irrigation, E) aspiration, F) mesiodistal end radiography; a: cervical third, b: middle third; c: apical third.

RESULTS

The results obtained for measurements of the cervical third were in agreement with the assumption of normality, and were therefore analyzed using a parametric test. On the other hand, measurements of the middle and apical thirds were not normally distributed, and so were compared using non-parametric tests. Specifically, measurements of the cervical third before and after channel shaping were compared using a paired-sample t-test, and measurements of the middle and apical thirds were compared using the Wilcoxon signed-rank test.

The correlations of measurements taken in the cervical third of the root canal were calculated using the Pearson correlation coefficient, while those of measurements taken in the middle and apical thirds were calculated using the

Spearman coefficient. The variables were then plotted using dispersion diagrams. Table 1 shows descriptive statistics derived from the measurements in the cervical, middle, and apical thirds, both before and after shaping of the root canal.

Table 1 – Descriptive statistics (n, minimum, maximum, mean, and standard deviation [SD]) derived from measurements in the cervical, middle, and apical thirds both before and after shaping of the root canal.

Variable		n	Minimum mm²	Maximum mm²	Mean mm²	SD
Cervical third	Before	40	0.081	1.210	0.588	0.287
	After	40	0.217	2.421	1.220	0.547
Middle third	Before	40	0.040	1.183	0.448	0.246
	After	40	0.101	2.710	1.060	0.582
Apical third	Before	40	0.086	1.267	0.365	0.279
	After	40	0.181	2.944	0.819	0.637

The surface area of all root canal thirds had significantly increased following the procedure (cervical third: $T = -13.225$, $p < 0.0001$; middle third: $W = 410$, $p < 0.0001$; apical third: $W = 410$, $p < 0.0001$; Figure 2). In addition, the surface area of the root canal prior to shaping was positively correlated with that after shaping (cervical third: $r = 0.924$; middle third: $r = 0.98$; apical third: $r = 0.993$; Figure 3).

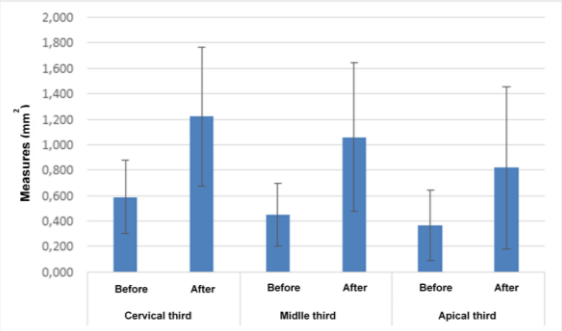

Figure 2 - Mean surface area measurements of the cervical, middle and apical thirds both before and after root canal shaping. Error bars show standard deviation.

DISCUSSION

Periodontal disease is the most common oral disease in cats and dogs (Helieh & Puleo, 2011). The condition is important, because it can jeopardize organ functioning in other systems if not appropriately treated. Locally, the loss of bone insertion caused by periodontal disease may be responsible for inflammation of the dental pulp of the dental pulp, causing pain and suffering to the animal. This discomfort can of course directly influence the animal's appetite for food, and can ultimately lead to malnutrition, weight loss, and deteriorating quality of life (Gioso, 1993; Fechio, 2009).

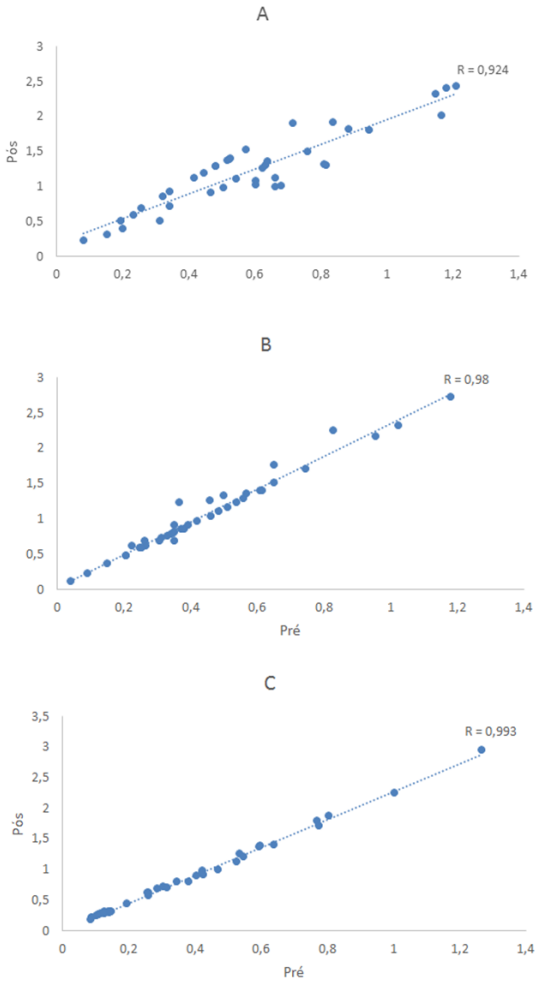

Figure 3 Correlation of root canal surface area measurements taken before shaping of the canal with those taken after the shaping. A) cervical, B) middle, and C) apical.

Therefore, when such a point is reached, intervention must be immediate; and in order to avoid tooth extraction, endodontic therapy is indicated. Such a procedure is usually

undertaken by veterinarians who have the necessary equipment, practical knowledge, and expertise to perform specialized veterinary dental procedures (Tutt, 2007). Endodontic treatment should respect some basic principles, including shaping and cleansing of the root canal; and although complete removal of necrotic tissue and debris from the root canal system would be ideal, in most cases a significant reduction of this content is sufficient to stop infection. The goals are to reduce the microbial population in the root canal, and to expand the canal to create the ideal physiological and morphological conditions for obturation. This provides a suitable environment for recovery and regeneration of the periapical tissues (Fouad, 2011).

In the specific case of endodontic treatment of dogs, variations in internal anatomy impede contact between the endodontic file and the internal walls of the root canal during preparation, There are in fact no preparation techniques that are able to completely cleanse the root canal system (Baratto-Filho et al., 2004; Barbizam et al., 2002; Fariniuk et al., 2003).

Shaping is the most delicate and lengthy procedure of the whole of root canal therapy. The procedure has two parts, which are performed simultaneously: irrigation, and biomechanical preparation using manual or rotary files.

In this study, hand files were replaced by ProTaper® rotary instruments, which are made of Ni-Ti alloys and have a modified design. That is, the ProTaper® instruments have tapers along the active tip, which significantly increases their cutting ability. These tapers are available in various sizes, and mean that fewer instruments are necessary for root canal preparation (Ruddle, 2001). Furthermore, the files are extremely flexible, and so are able to follow channel curvatures. The instruments used in this study were the SX, the S1, and the S2, known collectively as “shaping files”; as well as the F1 and F2, or “finish files,” where necessary.

With respect to the overall root canal anatomy, canal surface areas were larger after root canal preparation, showing that the ProTaper® instruments removed significant volumes of dentine (cervical third: $T = -13.225$, $p < 0.0001$; middle third: $W = 410$, $p < 0.0001$; apical third: $W = 410$, $p < 0.0001$). Regarding the shaping of specimens, the expansion of the apical third was significant. However, it is important to note that there was a positive correlation between the measurements in all of the analyzed thirds (cervical third: $r = 0.924$; middle third: $r = 0.980$; apical third: $r = 0.993$), which demonstrates an increase in the surface area of the root canal in all thirds measured. This result should correspond to the volume of a perfectly prepared canal of similar dimensions.

It is extremely important to remove necrotic and other debris from the apical region in order to minimize the risk of secondary infections. Therefore, irrigation with sodium hypochlorite and aspiration are essential to increasing the effectiveness of the cleansing procedure (Baratto-Filho et al., 2004). In this study, we assume that the significant increases in apical surface area and irrigation, which were made possible by the instrumentation, were sufficient to ensure proper cleansing. Nevertheless, imaging of the internal canal walls by scanning electron microscopy, especially at both the flattened areas and the isthmus, will be essential in assessing the real extent of expansion and cleansing of the root canal.

Unfortunately, we did not quantify the time spent shaping each dental specimen. However, the perception of the researchers was that the use of rotary systems in general significantly reduces operation time, and that this in turn decreases stress for the patients, the owners, and the professionals.

CONCLUSION

In this study, we conclude that the rotary instruments used were efficient in shaping root canals.

REFERENCES

ABINPET, Associação Brasileira da Indústria de Produtos para Animais de Estimação.http://www.rnpet.com.br/mercado-pet-abinpet-divulga-dados-consolidados-referentes-a-2013. Last accessed in May 2015.

BARATTO-FILHO, F. et al. Morphometric analysis of the effectiveness of different concentrations of sodium hypochlorite with rotary instrumentation for root canal cleaning. **Brazilian Dental Journal**, v.15, n.1, p.36–40, 2004.

BARBIZAM, J.V.B. et al. Effectiveness of manual and rotary instrumentation techniques for cleaning flattened root canals. **Journal of Endodontics**, v.28, n.5, p.365–366, 2002.

DEBOWES, L.J. et al. Association of periodontal disease and histologic lesions in multiple organs from 45 dogs. **Journal of Veterinary Dentistry**, v.13, p.57–60, 1996.

FARINIUK, L.F. et al. Histologic analysis of the cleaning capacity of mechanical endodontic instruments activated by the ENDOflash system. **Journal of Endodontics**, v.29, n.10, p.651–654, 2003.

FECCHIO, R.S. Prevalência de afecções orais em cães na casuística cirúrgica do Hospital Veterinário da Universidade Metodista de São Paulo. **Revista CFMV**, n.48, p.27–31, 2009.

FOUAD, AF. The Microbial Challenge to Pulp Regeneration. **Advanced Dental Research**, v.23, p.285–289, 2011.

GIOSO, M.A. Odontologia veterinária – Periodontia. **Revista Cães e Gatos**, v.8, n.45, p.16–22, 1993.

HELIEH, S. et al. Review Article: Animal models for periodontal disease. **Journal of Biomedicine and Biotechnology**, p.1–8, 2011.

HOFFMANN, T. et al. Epidemiology of periodontal disease in poodles. The **Journal of Small Animal Practice,** v.37, p.309–316, 1996.

HOLT, S. et al. Porphyromonas gingivalis, Treponema denticola, and Tannerella forsythia: the 'red complex', a prototype polybacterial pathogenic consortium in periodontitis. **Periodontology 2000**, v.38, p.72–122, 2005.

KYLLAR, M. et al. Prevalence of dental disorders in pet dogs. **Veterinary Medicine** (in Czech), v.50, n.11, p. 496–505, 2005.

LUND, E.M. et al. Health status and population characteristics of dogs and cats examined at private veterinary practices in the United States. **Journal American Veterinary Medicine Association,** v.1, n.9, p.1336–1341, 1999.

PIHLSTROM, B.L. et al. Periodontal diseases. **Lancet,** v.19, n.9499, p.1809–1820, 2005.

RUDDLE, C.J. The ProTaper® endodontic system: geometries, features and guidelines for use. **Dentistry Today**, v. 20, n.10, p.60-67, 2001.

TUTT, C. **Small Animal Dentistry: A manual of techniques**, chapter 10, p.212–233, 2007.

WADDINGTON, R.J. et al. Reactive oxygen species: a potential role in the pathogenesis of periodontal diseases. **Oral Diseases**, v. 6, n.3, p.138–51, 2000.