ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)
IJDSIR : Dental Publication Service
Available Online at: www.ijdsir.com
Volume – 4, Issue – 6, December - 2021, Page No. : 197 - 202

Comparison of the dentinal crack formation at the resected root ends prepared with conventional and ultrasonic technique during surgical apicoectomy using Dental Operating Microscope at 20 X, Otoscope at 4X and Ophthalmoscope at 15X magnification

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Citation of this Article: Dr. Pradnya Nikhade, Dr. Manoj Chandak, "Comparison of the dentinal crack formation at the resected root ends prepared with conventional and ultrasonic technique during surgical apicoectomy using Dental Operating Microscope at 20 X, Otoscope at 4X and Ophthalmoscope at 15X magnification", IJDSIR- December - 2021, Vol. – 4, Issue - 6, P. No. 197 – 202.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aim and objectives: This study aimed at determining the effect of root- end resection, ultrasonic and conventional preparation of root-ends, on the incidence of crack formation and propagation in the resected root end, by using a Dental Operating Microscope, Otoscope and Ophthalmoscope and comparing their accuracy on the detection of cracks.

Materials and methods: Thirty two, extracted, human, permanent premolars for orthodontic purposes were selected for this in vitro study. The root canal preparation was performed using conventional method. The apical 3 mm of each root were resected perpendicular to the long axis. The samples were divided in two groups. Group I and Group II had the root ends prepared using conventional technique with micro-bur and ultrasonic technique tip were observed for identification of formation of dentinal cracks.

Observations and results: All 32 specimens, 8 of which contained cracks, were evaluated by two independent observers viewed the teeth using Otoscope at 4X magnification (group Ia and IIa), Ophthalmoscope at 15 X magnification (Ib and IIb), a DOM at 20 X magnification (Ic and IIc).To determine the effectiveness of each visualization technique, the data were collected and compared to the predetermined standard (8 cracked, 24 not cracked) with a one-tailed Fisher's exact test (a = 0.05) using the NCSS statistical software. The sensitivity of DOM was highest and Ophthalmoscope least. The specificity of DOM was highest for DOM and least for

Ophthalmoscope. The accuracy of DOM was highest and Otoscope least.

Conclusion: It was concluded that the ultrasonic method created more number of cracks than the micro-bur. The DOM showed greater sensitivity followed by Otoscope and Ophthalmoscope.

Keywords: Dentinal crack formation, Micro-burs, ultrasonic tips, DOM, Otoscope, Ophthalmoscope.

Introduction

Nedderman et al evaluated the surface properties of resected roots obturated with gutta-percha that had been sectioned by different bur configurations with high- and low-speed handpieces. A low-speed diamond saw was used for control resections (1). Parsons and Stanek used scanning electron microscopy to evaluate surface topography of resected root-ends.In a recent study evaluating microleakage of root-end fillings (2). Saunders et al. noted the presence of dentin cracks in resected root-ends prepared with ultrasonics. In a study comparing incomplete root fractures associated with obturation techniques (3), Onnick et al. used a stereomicroscope at 40 magnification and observed dentin fractures in teeth with no canal preparation. In a recent study evaluating microleakage of root-end fillings (4), Saunders et al. noted the presence of dentin cracks in resected root-ends prepared with ultrasonics (9).

Martin and Cunningham et al. advocated the use of ultrasonics for canal instrumentation. Recently ultrasonic root end preparation techniques for endodontic surgery have gained popularity (5,6).

Recent studies by Saunders et al and Layton et al demonstrated the presence of root end cracks after ultrasonic preparation. Layton et a1 demonstrated a significantly greater number of cracks following root resection and ultrasonic root-end preparation compared to teeth with root resection alone. Direct and indirect image of the root end is the first hand information which allows the better diagnosis. Operator experience, observation time, the level of operator's eye fatigue, and other distractions may perhaps manipulate the visual analysis. Independently assessed vision is insufficient to properly evaluate resected root end for cracks, entirety of resection, and seldom anatomical variations (10). Bellizzi and Loushine (11) justified improved light source and enlargement of vision as adjuncts for posterior quadrant surgery similar to the conclusions derived by Rubinstein and Kim (12).

Carr put forth the inception of aids to augment vision in Endodontics. They concluded that the results paralleled those of other medical specialties, like neurosurgery, ophthalmology, and microvascular surgery (13).

The amalgamation of superior lighting source and magnification has been made first position due to fiberoptic headlamps, loupes, the surgical operating microscope, the Orascope, introduced by Bahcall and Barss(14). The significance of visual enrichment during endodontic management has been documented and exemplified by the American Dental Association. The prognostic value of surgical intervention in endodontics depends immensely on quite a few factors.

The recent advances of microsurgical trials like the use of a DOM, micro sized instruments, and ultrasonically active tips in association with biomimetic root canal obturation materials display high success rate of microsurgical endodontic management. The etiology of dentinal cracks and defects during microsurgical procedures have been investigated long back but focused on the ultrasonically prepared root-ends. When compared with bur cavity preparation, ultrasonic cavity preparation showed quite higher frequency of crack formation in the walls of root-end cavities. Also previously accessible dentinal defects may propagate

fast by ultrasonic root-end preparation. It has been revealed by a surgical operating microscopic inspection before and after ultrasonic preparation.

This study is aimed at determining the effect of root- end resection, ultrasonic and conventional preparation of root-ends, on the incidence of crack formation and propagation in the resected root end, by using a Dental Operating Microscope (DOM), Otoscope and Ophthalmoscope and comparing their accuracy on the detection of cracks.

Materials and Methods

Thirty two, extracted, human, permanent premolars for orthodontic purposes were selected for this in vitro study. All specimens had mature, intact apices and no previous endodontic therapy. They were kept in 100% humidity until used. Buccal-lingual and mesio-distal radiographs were taken to evaluate the number of canals and canal curvature. All teeth were initially examined for the presence of root surface cracks using 20 X magnification under Stereomicroscope. The root samples were covered with one layer of Aluminium foil and embedded in acrylic resin. The samples with the foil were removed and hydrophilic vinyl poly-siloxane impression material was placed around the root to simulate the P-D ligament. For standardization, the crown of tooth was sectioned 2 mm above the proximal CE Junction for coronal access using a diamond disk and an ISO size 10 Flexofile (Dentsply/Maillefer, Tulsa, OK) was inserted to the apical foramen. The working length was defined as 0.5 mm shorter than this length. Gates Glidden drills (Dentsply/Maillefer) were used to prepare the root canal to a length 5 mm short of the established working length. The remaining 5 mm was instrumented with Flexofiles, in a serial fashion, to ISO size 50 at the working length. Root canals were prepared using standard step back technique. (2) 2.5% sodium hypochlorite () for canal irrigation was used for root canal preparation. The access openings were made using a high speed #4 round bur. The working length was determined by inserting a #10 file into the canal until it was just visible at the apical foramen and subtracting 1 mm. Gates Glidden drills (Union Broach, Emigsville, PA) #2 to 4 were then used to remove the cervical bulge of dentin and flare the canal orifice. The coronal 2/3 of the root canals were then instrumented using the crown-down method in 1-mm increments. An apical step-back method using 1mm increments was used to join the coronal and apical portion of the canals. The final file size used at the working length was considered as master file. Three Each canal was dried with paper points, and a master Gutta- Percha cone (Hygenic, Akron, OH) was selected that provided “tugback” within 0.5 mm of working length. Grossman’s sealer was introduced into the canal on the master cone, and lateral condensation was accomplished using the spreader with fine accessory points until the spreader could not penetrate more than 2 to 3 mm beyond the orifice. The apical 3 mm of each root were resected perpendicular to the long axis with a multipurpose bur (Dentsply/ Maillefer) in a high-speed handpiece using water spray. The resected root ends were evaluated at X20 magnification with a Stereo microscope (Micro Enterprises, Inc., Norcross, GA) to ensure that no cracks were present at the conclusion of the root-end resection.

The samples were divided in two groups.

Group I- The root ends were prepared using conventional technique with large round bur number

8 which were observed for identification of formation of dentinal cracks.

Ia - Otoscope at 4X magnification,

Ib - Ophthalmoscope at 15 X magnification

Ic - DOM at 20 X magnification

Group II- The root ends were prepared using ultrasonic technique with tip number 3 on the lowest frequency setting which were observed for identification of formation of dentinal cracks.

IIa- Otoscope at 4X magnification

IIb- Ophthalmoscope at 15 X magnification

IIc - DOM at 20 X magnification

The specimens were prepared for clinically relevant viewing by mounting each root in the center of a 4cm diameter sheet of rubber dam material in which a 0.5-mm hole had been punched. The rubber dam with the tooth was placed over the opening of a plastic canister, 3 cm in diameter and 5 cm in height. With the rubber dam stretched tightly and the tooth suspended in the center of the canister, the rubber dam was secured by an elastic band.

The root was adjusted with digital pressure until approximately 0.5 mm of the apex was extending above the rubber dam. Five plastic trays were used, each designed with 10 numbered wells, to accommodate 10 canisters. The trays served as a platform on which the observations were made. The trays containing the canisters and specimens were placed in a humidor until the viewing sessions. The teeth were randomized before each viewing method and placed into the numbered wells within the trays. All 32 specimens, 8 of which contained cracks, were evaluated with each viewing method. A minimum of 24 hours elapsed between viewing sessions. Two independent observers viewed the teeth using Otoscope, Ophthalmoscope, a DOM. The trays containing the specimens were placed on a bench top and viewed from a seated position. The observer was not permitted to pick up the tray or change its orientation. A dental operatory light was used for illumination of the specimens in groups 1 and 2. Viewing with the Otoscope was performed with the 1.8-mm diameter probe mounted on a test tube stand 5 mm above the root surface to standardize the level of magnification for each examiner. Each specimen was assessed and a diagnosis of cracked, not cracked, or unsure was made and recorded. In recording the data for statistical analysis, the answer was deemed correct or "diagnostic" if the tooth was correctly identified as having or not having a crack. If the observer selected "yes" or "no" incorrectly or if they chose "unsure," the response was deemed incorrect or "not diagnostic." To determine the effectiveness of each visualization technique, the data were collected and compared to the predetermined standard (8 cracked, 24 not cracked) with a one tailed Fisher's exact test (a = 0.05) using the NCSS statistical software package The correct and incorrect responses were then utilized to calculate the sensitivity, specificity, and accuracy as described by Brunette. Sensitivity is the proportion of the roots containing cracks that were correctly diagnosed as having cracks. Specificity is the proportion of the roots without cracks that were correctly diagnosed as not having cracks. Accuracy is the proportion of the diagnoses that agreed with the known root condition. To compare the visualization techniques, a two-way analysis of variance was performed.

Observation and Results

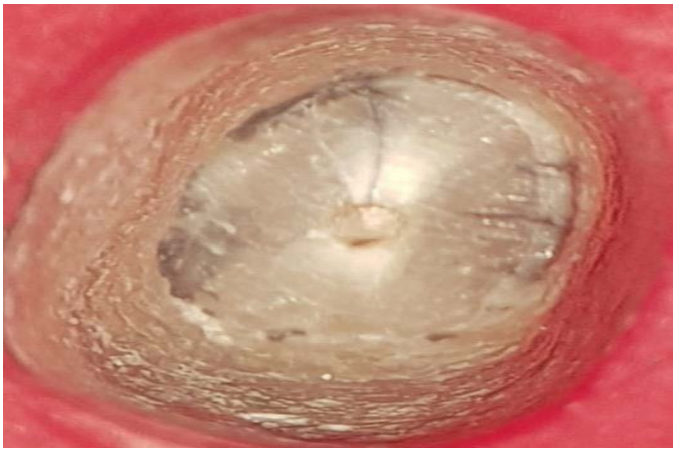

Figure 1

Table 1: Results of root crack identification

	Otoscope (%)	Ophthalmoscope (%)	DOM(%)
Sensitivity	35	19	81
Specificity	12	6	18
Accuracy	23	45	59

Sensitivity = proportion of roots with cracks that were correctly diagnosed; Specificity = proportion of roots without cracks that were correctly diagnosed; Accuracy = proportion of diagnoses that agreed with known tooth condition.

Where, A and B are two independent observers.

Group 1 – Retrograde Cavity preparation with Ultrasonic tips under Otoscope at 4X magnification

Group 2 - Retrograde Cavity preparation with Ultrasonic tips under Ophthalmoscope at 15 X magnification

Group 3 - Retrograde Cavity preparation with Ultrasonic tips under Dental operating microscope at 20X magnification

Group 4 - Retrograde Cavity preparation with Micro-bur under Otoscope at 4X magnification

Group 5 - Retrograde Cavity preparation with Micro-bur under Ophthalmoscope at 15 X magnification

Group 6 - Retrograde Cavity preparation with Micro-bur under Dental operating microscope at

20 X magnification

Y – Crack seen

N –No crack seen

Discussion

Observations were made with the root apex placed in a specimen holder designed from a plastic box and rubber dam sheet. This way the isolation of root apex could be done leaving only 0.5 mm of the lateral root surface uncovered. Covering up the lateral root surface was obligatory due to propagation of cracks along this surface made detection of dentinal cracks very clear.

Although the dentinal cracks evident in our study were created via a different mechanism than those observed by Layton et al, the types of cracks that we experienced were reliable with their findings.

Three types of cracks were seen: -

- Canal cracks (both complete and incomplete),
- Intradental cracks, and
- Cemental cracks.

A low sensitivity of 19% for Group Ia, IIa was the result of the high number of false negatives. The specificity was lowest for Group Ib, IIb. The accuracy of Group Ic, IIc was the lowest of the three groups, at 23%. This result suggests that the examiners could not see the cracks and that their responses were no more accurate than random guessing.

Two factors, specifically light reflection and irregularities in the resected root end, made identification of dentinal cracks difficult and may have resulted in greater observer.

Conclusion

From the study conducted it was concluded that the ultrasonic tip used for root end preparation after surgical endodontics observed to be causing more microcracks compared to micro-bur. The identification of cracks was done under DOM, Otoscope and Ophthalmoscope. Sensitivity and accuracy were highest for DOM followed by Otoscope and Ophthalmoscope. The specificity was observed highest for DOM followed by Ophthalmoscope and Otoscope. DOM may be the gold standard aid in magnification, small handy gadgets like Otoscope and Ophthalmoscope may prove to be used as chair side gadgets to observe the microcracks at resected root ends.

Acknowledgement: I would like to express my deep gratitude to Dr. Vedprakash Mishra and Dr. Minal Chaudhary for their patient guidance, enthusiastic encouragement and useful critiques of this research work. I would like to thank the DMIMS (Deemed to be

university) for allowing me to conduct the study in stipulated time.

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