Investigating the effect of applying oxalate potassium on human roots (dentin) permeability comparing with smear layer produced during instrumentation, by spectrophotometer

Ashraf H. DDS, MS¹, Sedghi B, DDS, MS², Kuzekanani M. DDS, MS³

¹Assistant Prof., Dept. of Endodontics, Dental School, Shahid Beheshti University of Medical Sciences, Tehran-Iran; ²Endodontist; ³Assistant Prof., Dept. of Endodontics, Dental School, Kerman University of Medical Sciences, Kerman-Iran.

ABSTRACT

Purpose: The aim of this study was to determine the effect of the artificial layer produced by oxalate potassium on permeability of human root's dentine comparing with the smear layer produced by root canal therapy.

Materials & Methods: Seventy extracted mandibular premolars which had one root also the canal was direct without any resorption, decay nor advanced periodontal disease, were chosen. The end of the roots were completely sealed and no calcification nor breakage were observed in them.

Samples were divided into four groups randomly: two test groups and two control groups. Each test group consisted of 30 samples and control groups contained 5 samples each. In order to measure permeability of dye through dentin, the spreading cabinet method was used and the amount of 2% methylene blue penetrated thorough the canal wall was calculated after 72 hours. Samples were evaluated by spectrophotometer with wave length of 640.

Results: In negative control group, no penetration was observed and also in the other three groups no statistical significant difference in dye permeability was observed. The greatest amount of permeability was in the absence of smear layer. Natural smear layers were second and artificial smear layer created by applying oxalate potassium was third.

Discussion: Therefore oxalate potassium can be applied in infectious canals after removal of smear layer which is full of micro-organisms and poisonous products in order to reduce dental tubule's penetration.

Conclusion: However sufficient investigations should be conducted in-vivo regarding tissue biocompatibility and harmlessness of this compound.

INTRODUCTION

Bacteria and their toxins are one of the factors that can create disease in the pulp and periodontal area, which will eventually cause infection. So, any factor effective on reducing permeability may play an important part in the success of root canal therapy. Therefore root permeability because of dentinal tubules which leads to exchanging harmful stimulators between root canal and the external surface of the root, should be investigated in a study which will be a priority in the field of endodontic research. One of the factors directly affecting dentinal permeability in root canal therapy is smear layer formation during instrumentation.¹

It has been reported that smear layer
formation reduces dentinal permeability up to 25-49% (Fogel et al. 1990). This layer in fact acts as a protecting barrier.

For many years root canals have been filled without removing smear layer with the success rate of 95% (3,4). On the other hand, according to Branstrom in 1994, smear layer which consists of micro-organisms and their products that can act as an infectious source irritating periapical tissue continuously. (5)

And if we remove this layer in the case of canal contamination dentinal tubules will also get infected, because of increase in dentinal permeability in the absence of smear layer up to 5 or 6 times more than normal. Therefore we should ask ourselves: Shall we leave the smear layer or remove it or should we after removal replace it with an artificial layer which would have the advantages and not the disadvantages of smear layer.

In this study after removal of smear layer, 30% oxalate potassium was applied on the canal wall and changes in the permeability of dentin according to methylene blue penetration were evaluated. The results were compared with cases which the smear layer was left over the root canal. Spectrophotometer was used in order to calculate penetration of dye which the measuring unit was optical density (O.D).

The first time which the existence of smear layer was reported was in 1976 by McComd and Smith. (6) Smear layer is a mixture of organic and inorganic debris which develops after instrumentation. The layer is amorphous, irregular and granular which also contains dentin and tissue particles, odontoblastic process and bacteria. (7-9) A lot of efforts were attempted in order to seal dentinal tubules and reduce their permeability after smear layer removal. For the first time in 1981, Greenhill and Pashly used 30% oxalate potassium in order to seal dentinal tubules and therefore reduce dentin permeability and tooth sensitivity. (10) Applying oxalate potassium over dentin will create oxalate calcium crystals in various sizes inside and over the entrance of dentinal tubules.

In another study in 1981, Pashley used 3% half – neutralized oxalic acid along with 30% oxalate potassium for the same purpose. Dentinal permeability due to insoluble oxalate calcium crystals was reduced up to 98.25%. (11)

Pashly and Galloway applied different compounds of oxalate on smear layer in another study and reached to the conclusion that dentin is a resisting barrier against acid and also it is enriched by calcium and carboccollate groups which may be useful in chemical connections.

In the present study we compared the permeability of dentin, when oxalate potassium was applied in contrast to smear layer. The research method was experimental and the technique used was observation.

**MATERIALS & METHODS**

Seventy mandibular premolars which had one root and also one canal were chosen with the following characteristics:

1. Healthy teeth, without caries, filling, history of trauma and also advanced periodontal disease. They were extracted because of orthodontic or prosthodontics treatments.
2. Fully matured teeth with completely closed root tips.
3. Root without any curvature and extensive calcification.
4. Roots without any fracture.

The teeth were divided randomly into two test groups containing 60 teeth and two control groups comprised of 10 teeth. The teeth in the test group were divided randomly into two groups, each group contained 30 teeth titled 1 and 2. Also, the control group was divided into two groups randomly which each group was comprised of 5 tooth that the groups were titles positive and negative control groups. The teeth were cleaned from soft and hard tissues immediately after extraction with mild strokes by a currette. In order to disinfect the surface of the teeth they were placed in 5.25 percent hypochlorite for 24 hours. (12,13) Afterwards, they were kept in 9% normal saline in room temperature until examination time. Access cavity was
provided for all the teeth by standard method. The apical ends of the roots were removed 2-3 mm in order to provide roots with same lengths. The procedure was accomplished by a rotary diamond disk with a 700 rpm speed along with water irrigation, on an right angle to linear axis of the root. A number 15k-file and also periapical radiograph were used in order to make sure that the root canal is not calcified and also there is only one canal.

In order to reduce interfering variables in this study inner and outer surfaces were prepared by standard technique. Number 20 or 25k-file was placed in the canal down to the root tip, so as the working length was determined 0.5 mm shorter than the length observed earlier. In order to clean and shape the canal stepback method was used and circumferential filling by 150k-files from 15 to 45 was applied. Between each two file recapitulation and irrigation was performed. Flaring was continued up to four numbers higher (number 70) according to stepback technique, reducing 1 mm of the length of the file last placed in the canal. In the first test group after applying instruments canals were irrigated by normal saline, syringe of 10 cc volume and 25 gauge needle, so as that needle was introduced through the canal up to 2/3 of the working length. So as that smear layer was left over the canal.

In the second test group and also negative and positive control groups in order to remove the smear layer, in all the procedures of canal preparation after introducing a file into the canal, it was irrigated by 5.25 percent hypochlorite. The irradiation procedure was applied by a 10 cc syringe and needle of 25 gauge which can be placed into the canal up to the working length. Afterwards in order to change the patency of the canal and also prevent dentin particles from obstructing the apical area, file number 10 was used. Also the canal was irrigated by 2cc %17 EDTA and was left in the canal up to 15 minutes for maximum effect. Later the canal was irrigated with 10cc EDTA solution for 2 minutes by a syringe needle appropriate for placing into 2/3 of the working length. Afterwards 10cc. 5.25 percent hypochlorite solution was applied. In the end canals were rinsed with 10cc, %0.9 normal saline.

The next step was removing cementum, which was conducted by a taper diamond bur mounted on a high speed hand piece, smoothly cutting 0.5mm of external surface of the root along with water spray. Elimination of cementum is in fact elimination of interfering variables, which would load to exact determination of dentine permeability.

Afterwards, the teeth in the second test group which had no smear layer were confronted with %30 oxalate potassium solution by placing a paper in the canal for 2 minutes which had been soaked in this solution, in order to create insoluble oxalate calcium crystals due to chemical reaction.

In order to get assured that smear layer has been eliminated and natural smear layer has been created, following preparation of teeth SEMs were taken. So as that 3 teeth were prepared. In the first one the smear layer was not omitted but in the second one was omitted, in the third sample artificial layer was created in the place of smear layer.

Two longitudinal grooves were made across the mesial and distal side of the root and the teeth were divided into buccal and lingual halves by applying force with a forceps. From all of the tooth a half was kept in the electronic microscope unit which were dried in a drying machine. Later in order to evaluate the samples with SEM they were covered with gold and pictures requested were taken from inside the canal.

The apical area of test groups 1 and 2 and also positive control group which had been cut in an right angle to the linear axis by a diamond disk, were completely dried and sealed with 2 nail varnish layers.

In the negative control group all the root's external surface from apical area to CEJ was covered with 1 nail varnish layers. In order to evaluate dye penetration spreading cabinet method was used. Penicillin vials were provided for each tooth sample. The center of the plastic cover of vials were prepared in order to place the teeth in the cover at which from the CEJ area downwards to apex were in the vial. The space between the tooth and plastic cover was filled with glue wax so that
no openings remained. Therefore the teeth were fully fixed and sealed into the plastic cover of the vial. Later the vial was filled with 9% normal saline so as the teeth hanging from the plastic cover were completely inside the normal saline. Pastor pipet was used as a source for storing dye, which was placed in the CEJ area of access cavity and held and sealed to its place by glue wax.

Then with a 2 cc syringe 2% methylene blue was poured into the pipet and the solution flew into the tooth canal. In order to compose 2% methylene blue, 0.1 gr methylene blue tablet was dissolved in distilled water. After 72 hours all the samples were brought out from normal saline and the contents of the vials were evaluated by spectrophotometer with a wave length of 640nm in order to measure dye penetration.

RESULTS

In order to investigate coherent samples and compare the dependent variables of dentin permeability between groups, unilateral variance analysis method was used.

According to statistical analysis dentin permeability in the first test group with smear layer was more than second test group with artificial layer and the highest dentin permeability was without the smear layer. After removing smear layer and replacing it with oxalate potassium, dentin permeability is reduced a great deal. According to unilateral variance analysis, p – value in this test is calculated 0.0000. The results of this study is similar to studies of Fogel and Pashly-Reeder, Homer, Livingston in 1990, Pashley in 1978, and Galloway and Pashley in 1985.

In 1990, Fogel and Pashly after creation of smear layer witnessed %25-49% reduction in dentin permeability. This reduction was because of sealing dentinal tubules by organic and inorganic debris and smear layer deep down to 40 µm into tubules.

In 1978, Homer, Reeder, Livingston, Pashley came to the conclusion that etching dentinal surfaces and removing smear layer will create significant increase in dentin permeability (P<0.01). On the other hand, applying oxalate to dentinal surfaces will lower dentin permeability significantly (P<0.025).

DISCUSSION

In the present research because of complete removal of smear layer and confirming the fact by electronic microscope, in the SEM we observed open dentinal tubules and increased penetration comparing with the time that smear layer was not removed.

After using oxalate potassium, samples’ permeability was reduced clearly. The reason for permeability reduction following the use of oxalate potassium was the insoluble oxalate potassium crystals created in and between dentinal tubules that were responsible for proportional sealing of tubular entrance and reduction in transmission. So we can come to the conclusion that in order to reduce transmission of microorganisms and their products in infectious canals following removal of smear layer, oxalate potassium will induce great reduction in the amount of penetration through dentinal tubules which is one of the connecting routes between canal space and periradicular area. It is greatly recommended to further investigate amount of leakage in canals following smear layer removal and replacing it with oxalate potassium, but with different methods of canal preparation and also different sealers, specially sealers that have the power of bonding to dentin. The later part was stressed on because those in favour of using oxalate potassium believe that after applying this material on dentin surface an enriched layer composed of calcium and carbocyclic groups will be produced that may be useful in chemical connections between sealer and canal surface. However clinical use of oxalate potassium is only possible when the biocompatibility of this drug has been proved by testing on animals. Also, by studying the reaction of cementum, PDL and bone tissue
to oxalate potassium the harmlessness of this material to human tissue should be demonstrated.

REFERENCES

5. Sletzer S: Endodontontology. 2nd Ed. Williams, Wilkins 1988; Chaps 8, 11; 254-268, 357-362.