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The Effects of Two Root Canal Irrigants and Different Instruments on Dentin Microhardness (In Vitro Study)

Wiaam MO AL-Ashou
BDS, MSc (Asst Lect)

Department of Conservative dentistry
College of Dentistry, University of Mosul

الخلاصة

الأهداف: تتهدف الدراسة إلى قياس صلابة عاج قناة الجذر بعد استخدام نوعين من غسول الجذر (0.2% كلورهيكسدين و5.25% الصوديوم هايبوكلورايت) مع او بدون استخدام أنواع مختلفة من مبارد قناة الجذر (مبارد الفولاذ الصامد (k) ، مبارد النيكل تيتاني (k)أو مبارد النيكل تيتانيم الدوار).**المواد والطرق** قسمت الأسنان إلى أربع مجاميع وفقا لنوع الغسول المستخدم في تحضير قناة الجذر مع استخدام المحلول الملحي كمجموعة سيطرة، بعد ذلك تم تقسيم كل مجموعة إلى مجاميع فرعية حسب نوع الأداة المستخدمة في تحضير قناة الجذر. بعد أن تمت عملية الغسل والإعداد، قطعت الجذور إلى شرائح ،وقد تم قياس صلابة عاج السن باستخدام جهاز صلابة فيكرز(Vicker,s microhardness machin) ..**الاستنتاجات**: أظهرت نتائج هذه الدراسة إلى أن(الكلورهيكسدين) لا يؤثر على صلابة عاج الجذر بينما (الصوديوم هايبوكلورايت) يقلل من صلابة عاج السن بشكل معنوي ولاسيما باستخدام مبارد(الفولاذ الصامد) (k) و مبارد النيكل تيتانيم (k) بالمقارنة مع او مبارد النيكل تيتانيم الدوار.

ABSTRACT

Aims: To measure the microhardness of root canal dentin using two types of irrigating solutions(0.2% Chlorhexidine and 5.25% Sodium Hypochlorite) with and with out use of different types of root canal files (Stainless Steel-K files, Nickel-Titanium K-files or rotary Nickel-Titanium files). **Materials & methods:** The teeth divided in to four groups according to the type of irrigating solutions that used during root canal instrumentation with the use of normal saline as a control group, then each group sub divided in groups according to the instrument used in the root canal preparation, then after irrigation and preparation the roots sliced and root dentin microhardness measured using Vicker's microhardness machine. **Results**: The result of this study showed that the type of instrument and Chlorhexidine have no effect on the microhardness of root canal dentin while Sodium Hypochlorite significantly decrease the microhardness of root canal dentin especially when use with Stainless Steel K-files and Nickel-Titanium K-files than when used with rotary Nickel-Titanium files. **Conclusion:** The microhardness of root canal dentin not affected by the type of root canal instruments.,The use of 5.25% Sodium Hypochlorite as a root canal irrigation significantly reduce the microhardness of root dentin within 3 minutes**.**, The use of Sodium Hypochlorite as a root canal irrigant with stainless steel K-files or Nickel-Titanium K-files reduce the microhardness of root canal dentin to greater extend than when use with rotary Nickel-Titanium files because the working time required with Stainless Steel K-files or Nickel-Titanium K-files was on the average three times longer than the working time with rotary Nickel-Titanium files. The use of sodium hypochlorite as a root canal irrigant with stainless steel K-files or Nickel-Titanium K-files reduce the microhardness of root canal dentin**.**

Keywords: : microhardness, root canal irrigants, rotary Nickel-Titanium files.

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INTRODUCTION

Dentin microstructure and its properties are very important in restorative dentistry. Dentin is a hydrated complex composed of four elements: (1) oriented tubules surrounded by (2) a highly mineralized peritubular zone embedded in an intertubular matrix consisting largely of (3) type I collagen with apatite crystals and(4) dentinal fliud.(1) Knowledge of mechanical properties of human root canal dentin would help restorative treatment. Microhardness define as the resistance to local deformation and it tests based on the induced permanent surface deformation that remains after removal of load. Hardness measurement can be correlated with the other mechanical properties such as fracture resistance,

modulus of elasticity and yield strength. A strong relationship exists between microhardness of dentine and restorative bond strength. Any change in the microhardness of the root dentin may adversely affect sealing ability and adhesion of dental material such as resin cements and root canal sealers to dentin. So microhardness provides a first step toward predicting behavior of dentin/ restoration interfaces.[2]

The major objective of endodontic treatment is to remove the contents of the canal adjacent tissues in such away that the filling procedures that follow will be facilitated.[3]

Traditional root canal preparation is done by conventional stainless steel instruments. Since 1988 NiTi hand files have gained increasing popularity the canal preparation procedure can be quite time consuming and tedious with hand files. In an attempt to decrease time required and simplify canal preparation during instrumentation, engine driven and automatic devices have been developed. The preparation system represents a new generation of Nickel Titanium instruments currently available. It is use with Nickel Titanium control handpiec. It is used with contra-angle handpiece with adjustable torque and automatic declutching.[4]

It is well documented that instrumentation alone cannot clean all the internal surfaces of the root canal. Bacteria can be found on the root canal walls , within the dentin tubules and in lateral canals.[5] Therefore, root canal irrigation during the preparation of the root canal is very important for lubrication of the instruments, flushing out of root canal debris, chemical degradation of residual pulp tissue, chemical degradation of the smear layer on the instrumented surface, , chemical degradation of microbial biofilm both on instrumented and on uninstrumented surface, and antimicrobial action against the root canal microbial flora .[6,7]

Sodium Hypochlorite solution ranging from 0.5% to 5.25% have been recommended for use in endodontics. It has been used as an irrigant in endodontic for many years. Sodium Hypochlorite concentration greater than 1% will effectively remove organic component of the dentin and changes their component. Therefore, the microhardness of the root canal dentin will be chanded.[5, 8]

Chlorhexidine gluconate widely use as endodontic irrigating solution it has antimicrobial effect at 0.2%. [9] Chlorhexidine is cationic molecule structure because of this property Chlorhexidine has residual effect.[10,11] Also Chlorhexidine has low surface tension so can penetrate the dentinal tubules easily.[12] Some studies found correlation between microhardness of root dentin and irrigation solutions. Also, it is of interest to investigate the effect of various file types on the microhardness of root dentin.

The aim of this study was to measure the microhardness of root canal dentin using two types of irrigating solutions which is the most popular used irrigating solutions in the collage of dentistry in the university of mousl (0.2% Chlorhexidine and 5.25% Sodium Hypochlorite) with and with out use of different types of root canal files (Stainless Steel-K files, Nickel-Titanium K-files or rotary Nickel-Titanium files).

MATERIALS AND METHODS

One hundred thirty human lower second premolars with straight roots extracted for orthodontic reason were used in this study (patients age 20-22 years). The samples were cleaned free of debris and calculus and were stored in tab water until used(not more than one week).

The method used in this study was described by Dayal *et al*. and Slutzky - Goldgerg et al,[4,13] in this method the teeth was collected and cleaned then the access to the root canal was prepared and the pulp tissue extirpated after that the teeth divided in groups according to the type of the instrument that used in the root canal preparation, after root canal preparation each root sectioned transversely and the hardness of root canal dentin then measured. [4,13], In this study after access cavity preparation and pulp extirpation, the teeth divided in to the following groups:

Group A: Ten teeth were kept as control, neither instrumented nor irrigated (which is the control group).

Group B: Forty teeth were divided into four subgroups as follow:

B1: Ten teeth irrigated with normal saline.
B2: Ten teeth were instrumented with Stainless Steel K-files (MANI, INC. JAPAN) to apical file size 45 ISO along normal saline irrigation.
B3: Ten teeth instrumented with Nickel Titanium K-files (Shenzhen superline Tech. com, Ltd) to apical file size 45 ISO along with normal saline irrigation.

B4: Ten teeth instrumented with rotary Nickel-Titanium files(Densply, Swiss) With NiTi control hand piece (Endo-Mate DT, Japan, Figure 1) up to file F3 along with normal saline irrigation. Larger diameter instrument like SX and S1, were used with torque value (3 Ncm) and smaller instruments likes S2 and, F1, F2, F3 were used with torque value (1 Ncm). The hand piece use at speed of 300 rpm.

Group C: Forty teeth were divided into four subgroups as follow:

C1: Ten teeth irrigated with 0.2% Chlorhexidine Gluconate

C2: Ten teeth were instrumented with Stainless Steel K-files to apical file size 45 ISO along with 0.2% Chlorhexidine Gluconate.

C3: Ten teeth instrumented with Nickel-Titanium K-files to apical file size 45 ISO along with 0.2% Chlorhexidine Gluconate.

C4: Ten teeth instrumented with rotary Nickel-Titanium files with Nickel-Titanium control hand piece up to file F3 along with 0.2% Chlorhexidine Gluconate. Larger diameter instrument like SX and S1, were used with torque value (3 Ncm) and smaller instruments likes S2 and, F1, F2, F3 were used with torque value (1 Ncm). The hand piece use at speed of 300 rpm.

Group D: Forty teeth were divided into four subgroups as follow:

D1: Ten teeth irrigated with 5.25% Sodium Hypochlorite.

D2: Ten teeth were instrumented with Stainless Steel K-files to apical file size 45 ISO along with5.25%Sodium Hypochlorite.

D3: Ten teeth instrumented with Nickel-Titanium K-files to apical file size 45 ISO along with 5.25% Sodium Hypochlorite.

D4: Ten teeth instrumented with rotary Nickel-Titanium fileswith Nickel-Titanium control hand piece up to file F3 along with 5.25% Sodium Hypochlorite. Larger diameter instrument like SX and S1, were used with torque value (3 Ncm) and smaller instruments likes S2 and, F1, F2, F3 were used with torque value (1 Ncm). The hand piece use at speed of 300 rpm.

Each root in group B to D was irrigated with a total volume of 10 ml of the irrigating solution (the type of irrigating solution according to the group) by using 10 ml plastic disposable syringes fitted with a 23 gauge needle (MERAB, Syria) that insert passively in the canal as near as possible to the apex with out engaging the walls (the canals were irrigated with 1 ml of irrigant between each file size with the final flush with the remaining irrigating solution after reaching the master apical file).

The time required for biomechanical preparation using rotary Nickel Titanium files was 3 minutes on an average and with Stainless Steel K-files and Nickel-Titanium K-files was 9 minutes.

After completion of the preparation, the roots were separated from the crowns, each roots was sectioned transversely at the middle third of the root, using diamond disk.

For microhardness test, the root samples were embedded in self curing acrylic resin, held in polyvinyl plastic ring and then polished using red mounted fin grained grinding stone, followed by abrasive paper of 80 to 100 grit. The specimens were then polished with rotary pergrinder microbolishing machine(Metaserv, Surrey, England). The microhardness measurement were performed using Vicker,s microhardness machine (Wolpert, German, Figure 2). The microhardness measurement was taken at four different points at distance 0.5mm from the lumen(Figure 3). Each measurement was carried out by using a 500g load for 10 seconds, oriented perpendicular to the surface.

Data were tabulated and statistically analyzed. They were analyzed using analysis of variance (ANOVA) followed by Duncan's Multiple Range Test at 5% level of significance to indicate if there were any statistical difference in the microhardness of root canal dentin between the groups.

Figure(1) Torque Control Handpiece for Rotary Nickel-Titanium File

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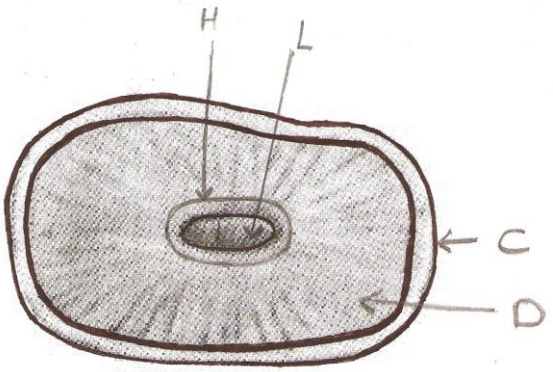
Figure (2) Vicker's Microhardness Machine



Figure(3) Cross section of the root show the area at which the microhardness of root canal dentin measured., L: Lumen of the root can , D: Dentin, H: area which the hardness measured(0.5mm from the lumen) , C: cementum

RESULT

The in vitro study show that there was no significant difference between group A and B(B1, B2, B3, B4) which represent the effect of different instrument on the microhardness of root canal dentin measured at 0.5 mm from the lumen when compare to the control group as shown in Table (1).

Tables (1) a-ANOVA and Duncan's Multiple Range Test for the Effect of Different Instrument on The Microhardness of Root Canal Dentin Measured at 0.5 mm from the Lumen.

	Degree of Free-dom	Sum of Square	Mean Square	F	Significant
Instrument					
Between	4	0.484	0.121	0.364	0.833
groups	45	14.934	0.332		
Within groups	49	15.417			
Total					

b- Duncan's Multiple Range Test

Treatment group	Number	Mean* ± SD**	Duncan*** grouping
A	10	60.604 ± 0.457	a
B3	10	60.755 ± 0.490	a
B1	10	60.785 ± 0.600	a
B4	10	60.868 ± 0. 629	a
B2	10	60.875 ± 0.490	a

*Mean of Vicker microhardness number in kg/mm².,** stander deviation., *** Mean with same letter are not significant., The level of significance ά = 0.05, p =0.05

Table (2) which represent the effect of irrigating solutions alone (without instrumentation) on the microhardness of root canal dentin measured at 0.5 mm from the lumen shows that B1, C1 have no effect on the microhardness of root canal dentin when compare to the control group while group D1 show significant reduction in the microhardness of root canal dentin measured at 0.5 mm from the lumen when compare to the control group.

Tables (2) a-ANOVA and Duncan's Multiple Range Test for the ffect of Irrigating Solutions Alone Root Canal Dentin Measured at 0.5 mm from the Lumen.

	Degree of Free-dom	Sum of Square	Mean Square	F	Significant
Irrigating solu-tion	3	142.431			
Between groups	36	52.348	47.477	32.650	0.000
Within groups	39	194.779	1.454		
Total					

b- Duncan's Multiple Range Test

Treatment group	Number	Mean* ± SD**	Duncan*** grouping
D1	10	56.288 ± 1397	a
A	10	60.604 ± 0.457	b
C1	10	60.647± 1.349	b
B1	10	60.685± 1537	b

*

Mean of Vicker microhardness number in kg/mm².,** stander deviation.,*** Mean with same letter are not significant.,The level of significance ά = 0.05, p =0.05

Table (3) which represent the effect of different irrigating solutions and different instruments on the microhardness of root canal dentin measured at 0.5 mm from the lumen shows groups C2, C3, C4 have no effects on the microhardness of root canal dentin when compare to the control group while groups D2 and D3 significantly reduce the microhardness of root canal dentin and there is no significant different between them, D4 also significantly reduce the microhardness of root canal dentin but to lesser extend than group D2 and D3.

Tables (3) a-ANOVA and Duncan's Multiple Range Test for the Effect of Different Irrigating Solutions and Different Instruments Root Canal Dentin Measured at 0.5 mm from the Lumen.

	Degree of Freedom	Sum of Square	Mean Square	F	Significant
Irri + inst*					
Between groups	6	1472.237	245.356	32	.000
Within groups	63	49.005	0.778	.650	
Total	69	1521.142			

*Different irrigating solution and different instruments.

b- Duncan's Multiple Range Test

Treatment	group	Number	Mean* ± SD**	Duncan***	grouping
D2		10	49.876 ± 0.571	a	
D3		10	50.471 ± 0.626	a	
D4		10	55.180 ± 0.762	b	
C2		10	60.515 ± 1.182	c	
C4		10	60.521 ± 1.024	c	
C3		10	60.603 ± 0.129	c	
A		10	60.604 ± 0.457	c	

*Mean of Vicker microhardness number in kg/mm².,** stander deviation., *** Mean with same letter are not significant., The level of significance ά = 0.05, p =0.05.

DISCUSSION

The action of endodontic instrument during chemomechanical preparation occur only in the root canal and dose not directly reach the entire radicular complex. Therefore, the cleaning of root canals is a challenge. This cleaning occurs during the chemomechanical preparation eliminating irritants such as bacteria and their subproducts, degenerated pulp and contaminated dentin. These process occurs by the mechanical action of the instruments against the principal canal wall with the chemical action of the irrigating solutions.[14,15]

The study involved measurement of the root dentin microhardness and to compare the effects of different files types, different irrigants and combination of them on the root dentin microhardness.

The result of this study demonstrated that the instrumentation with stainless steel K-files, Nickel-Titanium K-files and rotary Nickel-Titanium files have no significant effects on the root dentin microhardness when use with normal saline. this mean that the types of the instrument not produce any changes in the organic and inorganic component of root canal dentin.

The use of 5.25% Sodium Hypochlorite as a root canal irrigation with out instrumentation significantly reduce the microhardness of root dentin this due to organic dissolving properties of Sodium Hypochlorite on collagen component of dentin.(16) In addition to that Sodium Hypochlorite extract the Calcium ion from the dentin and decrease the calcium/ phosphorus ratio. [17, 18, 19] The current study agree with the study by Slutzky-Goldberg et al., (2004), Ari et al.,(2004) and Oliveira et al.,(2007) who conclude that Sodium Hypochlorite significantly reduces the microhardness of root canal dentin.[20, 21, 22]

Chlorhexidine dose not affect the microhardness of root canal dentin this agree with the finding of Ari et al.,(2004) who conclude that o.2% Chlorhexidine Gluconate seems to be an appropriate endodontic irrigation solutions because of it harmless effect on the microhardness of root canal dentin.[17] . But the result of the current study disagree with the finding of Oliveira et al.,(2007) who found that Chlorhexidine significantly reduces the microhardness of root canal dentin at 500 micron and 1000 micron from the pulp dentin interface, this because Oliveira et al.,(2007) use Chlorhexidine at a concentration of 2% and Chlorhexidine at this concentration may alter the mineral content of the dentin.[22]

The use of Sodium hypochlorite as root canal irrigant with stainless steel K-file or Nickel-Titanium K-files reduce the microhardness of root canal dentin to greater extend than when use with rotary Nickel-Titanium files because the working time required with Stainless Steel K-files or Nickel-Titanium K-files was on the average three times longer than the working time with rotary Nickel-Titanium files, this finding agree with finding of Dayal et al., (2007) and Slutzky-Goldgerg et al., (2004) who conclude that instrumentation with rotary Nickel-Titanium files with the use of Sodium Hypochlorite as a root canal irrigant affect the dentin microhardness to a lesser extend than stainless steel K-files or Nickel-Titanium K-files.[4, 13]

Farag and Hassanien (2000) found that reduction in root dentin hardness after the use of Sodium Hypochlorite as a root canal irrigant, was induced after one minute contact period with the canal walls. Considering the longer time required for root preparation in clinical situation, in addition to the possibility of leaving some chemical residuals in canal between visits so it may be anticipated that much more softening effect is induced on root canal dentinal walls.[16]

CONCLUSIONS

The microhardness of root canal dentin not affected by the type of root canal instruments.,The use of 5.25% Sodium Hypochlorite as a root canal irrigation significantly reduce the microhardness of root dentin within 3 minutes., The use of Sodium Hypochlorite as a root canal irrigant with stainless steel K-files or Nickel-Titanium K-files reduce the microhardness of root canal dentin to greater extend than when use with rotary Nickel-Titanium files because the working time required with Stainless Steel K-files or Nickel-Titanium K-files was on the aver-

age three times longer than the working time with rotary Nickel-Titanium files. The use of sodium hypochlorite as a root canal irrigant with stainless steel K-files or Nickel-Titanium K-files reduce the microhardness of root canal dentin.

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