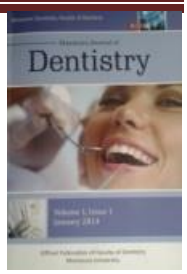

EFFECT OF CASTOR OIL AS A LUBRICANT ON 2SHAPE ROTARY INSTRUMENTS

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Abstract:

Aim: The current study aimed to evaluate the impact of viscosity of castor oil on deformity and fracture of 2Shape nickel titanium instrument during root canal preparation. **Methods**: two hundred mandibular first molars with mesio-buccal canals having angles of curvature ranging from 20° to 40° were divided into four equal groups each of 50 according to the viscosity of lubricant: group I (Castor oil 100%), group II (Castor oil 90%, group III (Castor oil 80%) and group IV(EDTA 17%). Then each groups divided into five subgroups (n=10). The root canals were prepared using 2Shape rotary instruments which examined before and after root canal preparation under electron microscope at different magnifications (10× and 50×) for any fracture or deformity. Collected data were then statistically compared to determine differences between the tested root canal lubricants. . **Results**: After using tested lubricant solutions, the Castor oil 80% showed the lowest fracture rate on 2Shape rotary instruments while EDTA 17% showed the highest rate. Castor oil 100% have the highest incidence rate of unwinding in comparison with other groups while castor oil 80% have the lowest rate of unwinding. **Conclusions**: Within the limitations of the present study, Application of Castor oil 80% as intracanal lubricants cause less fracture rate on 2Shape rotary instruments compared to other canal lubrication.

Keywords: Canal lubricants, Castor oil, EDTA, File Fracture, File Deformity, Biocompatiblity.

Introduction

Fracture of endodontic instruments is an unwanted complication that compromises treatment and might impact on the prognosis. Fracture of rotary NiTi instruments may occur without warning, even with brand new instruments, whereas fracture of stainless steel files is preceded by instrument distortion serving as a warning of impending fracture[1]. Cyclic fatigue and torsional stress are considered the main reasons for fracture of rotary nickel-titanium (NiTi) instruments.To overcome this disadvantage, there are many factors that can used as assess root canal curvature radiographically and instrument them carefully, set rotational speed and torque at low levels, use crown-down technique and use adequate lubrication during root canal preparation[2].

The lubricant should be environment friendly due to the need of safe climate, less harmful, and have superior tribological properties. The green lubricants are those that improve energy efficiency and reduce wear in the machinery while also increasing service lifetimes to reduce lubricant use [3].

Castor oil is a healthy vegetable oil that has the potential to be environmentally favourable friendly lubricants because of its biodegradability, renewability, and superior lubrication properties [4]. Castor oil can be used as root canal irrigating solution due to its antimicrobial activity where it has similar antimicrobial activity as 0.5% sodium hypochlorite when used for irrigation of necrotic root canals[5]. it can increases dentinal permeability[6] and has similar ability to remove smear layer from the root canals as 17% EDTA[7].Also it oil can fight candida, fungal infection[8] and it has sealing ability as root end filling material better than mineral trioxide aggregate, and glass ionomer cement[9].

Due to biocompatibility of castor oil, it can be used in treatment of arthritis, haemorrhoids, boost immunity and inflammation of the eye as early cataracts and dry eye because it contains ricinoleic acid which has excellent analgesic and anti-inflammatory[10,11]. Therefore, the aim of this in vitro study was to assess the impact of viscosity of castor oil on fracture and deformity of 2Shape instruments.

Materials and methods

Two hundreds mandibular first molars with a closed apex which were extracted for orthodontic or periodontal reasons were included in the present study. Hard deposits and

calculus were removed using ultrasonic scaler (Guilin Woodpecker Medical Instrument Co. Ltd, Guangxi, China) and the teeth were cleaned, disinfected and stored in distilled water to maintain hydrated until use.

Teeth with two separate mesial canals, two separate apical foramina and a canal width at the apex of approximately size 15 were included. Teeth with root resorption, root caries, fracture and open or large apices (apical diameter larger than size 15) were excluded.

A straight line access cavity was performed using a high speed hand piece(NSK, Shinagawa, Tokyo, Japan) with a long shank round bur and Ash Tungsten Endo-Z bur (Dentsuply Maillefer, Ballaigues, Switzerland), and mesio buccal canals were checked for apical patency with ISO #10 hand K-file instrument (Mani, Kiyohara Industrial Park, Utsunomiya, Japan).

Standardized radiographs were taken prior to instrumentation with K file of size 10 inserted into the mesio-buccal canal extending to the apical foramen. Root curvatures were determined using the Schneider's method[12]. Canals with 20 to 40 degrees of curvature were selected. All teeth were decoronated to a length of 18 mm by low speed double sided diamond disk (Kavo Kerr, Stockley Park, UK).

Two hundreds mesio-buccal canals were randomly allocated, with respect to their angles and curvature to ensure similar mean degree of root canal curvature between groups, into 4 groups of fifteen canals for instrumentation with the different lubricants types.

Group I has 50 canals which prepared with castor oil 100%, Group II has 50 canals which prepared with castor oil 90%, Group III has 50 canals which prepared with castor oil 80% and Group IV has50 canals that prepared with 17% EDTA

Each group were divide into 5 subgroups (n=10)

Before root canal preparation, all files were inspected at 10x and 50x magnification using electron microscope (JEOL JSM 6510 LV) to assure the absence of any distortion or deformity. In case of any distortion, the file was excluded.

Castor oil 90% was prepared by adding 90 ml of Castor oil and 10ml of ethyl alcohol in glass tube and shakes them well for 1 minute till obtained homogenous mix while Castor oil 80% was prepared by adding 80 ml of Castor oil to 20 ml of Ethyl alcohol.

The density of Castor oil was determined by the hydrometer and the kinematic viscosity was calculated by GALLENKAMP viscometer bath. Then the dynamic viscosity was determine through this equation Dynamic viscosity = kinematic viscosity / density.

The apical portion of canal was enlarged to a size #15 K-file then all canals were prepared using rotary 2Shape nickel-titanium instruments (Micro Mega, Besançon, France) where each 2Shape files) were prepared ten canals where they were immersed in the lubricant in each use and then they were introduced to the canals by Denjoy electric endodontic motor (Denjoy, Changsha City, Hunan Province, China) at speed 300 rpm and torque 1.5N.m. Between each file, canal was irrigated with 3ml of 5.25% NaOCl (Prime Dental Products PVT. LTD. Maharashtra. Indi) between each use of the file file using a 30-gauge side vented needle (Shanghai Mekon Medical Devices Co., Ltd, Shanghai, China).

Once the file reached the working length it was changed to the next one.# 10 k file was used to check the patency after each file. If the instrument showed fracture before preparation of ten canals, the data was recorded and the file was replaced by new one till ten canals were prepared.

After root canal preparation, all files were cleaned by immersion in Ethyl alcohol and placed in ultrasonic device to remove any debris then they were radiographed at 10 x and 50x magnification using electron microscope to detect any deformation or fractures.

Data were analyzed using the Statistical Package of Social Science (SPSS) program for Windows (Standard version 24). Qualitative data were described using number and percent. Association between categorical variables was tested using Monte carlo test when expected cell count less than 5.

Results:

Castor oil 100% has the highest viscosity (553 cp) while EDTA 17% has the lowest viscosity (4.2 cp) . the viscosity of Castor oil 90% is 147.8 cp and Castor oil 80% is 68.2cp.

The total number of files used for canal preparation was 12 files for group I [TS1(n=6) , TS2 (n=6)], 10 files for group II [TS1(n=5) , TS2 (n=5)], 10 files for group III [TS1(n=5) , TS2 (n=5)] and 13 files for group IV [TS1(n=6) , TS2 (n=7)].

Monte carlo test was used and showed that Castor oil 100% have the highest incidence rate of unwinding in comparison with other groups where there were 3cases of unwinding in this group but there are 2 case of unwinding in group II and group IV while group III have one case of unwinding.

Group IV have the highest incidence rate of fracture in comparison with other groups where there were 3cases of fracture in this group but there are only two case of fracture in group I while other group showed no fracture cases.

There are only one case of instrument fracture in Castor oil 100% group and only one case in EDTA 17% group.

There was insignificant difference in instrument surface deterioration between all groups where there were 2 cases of surface deterioration in each group.

There was insignificant difference in instrument surface deterioration between all groups where there were 4 cases of surface deterioration in group I and group IV while there is 5 cases in group II and group III (fig 1.2).

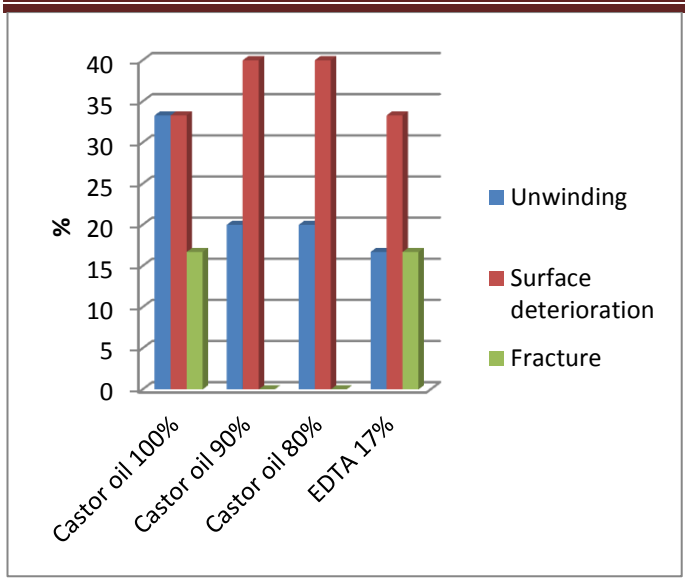

Figure (1): Frequency of deformity (TS1) among the studied groups

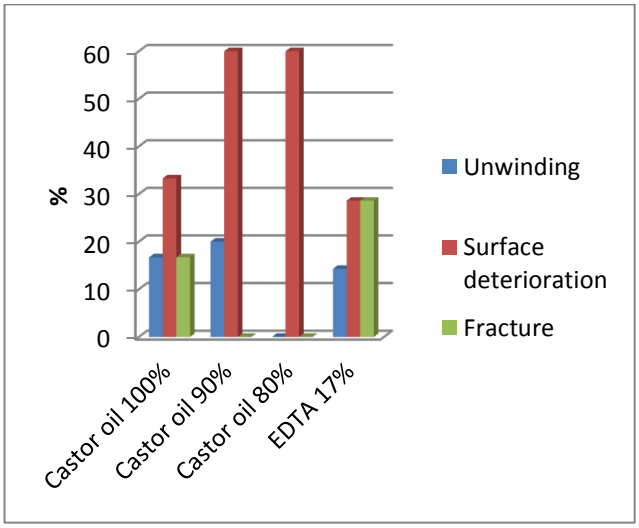

Figure (7): Frequency of deformity (TS2) among the studied groups

Discussion

The concepts of lubrication are very well defined by engineering. It is well known that proper lubrication decreases friction between surfaces in contact, resulting in an improvement in their useful life due to less cutting blade wear. The purpose of this study was to evaluate and compare the rate of deformity and fractures that may occur during the use of 2Shape rotary instrument with different viscosity of castor oil.

2Shape NiTi rotary file was chosen due to its cyclic fatigue resistance where it have been designed for root canal preparation with continuous rotation movement and is made of NiTi-alloy called T-wire which is a method which allows for an increased resistance to cyclic fatigue (+40%) and a better negotiation of curvatures which is in agreement with study of Uslu G et al[13] that showed that the cyclic fatigue resistance of 2Shape files at the intracanal temperature was higher than EndoSequence Xpress files and Twisted files.

The incidence rate of deformation and fracture were evaluated in natural root canals to simulate the clinical situations and to study chemical interactions of different viscosity of lubricant with normal dentin but the majority of researches used plastic blocks to test root canal instruments [14], which does not represent a clinical situation due to the physical and chemical difference between plastic blocks from human dentin.

To reduce torsional fatigue and avoid the rise in temperature caused by file friction, which causes a thermomechanical stress on the file, a low speed (300 rpm) was used and the instrument was not left in the canal for more than 20 seconds., which is in agreement with other study done by Lopes et al[15] who conducted that the cyclic fatigue resistance is lower when the rotational speed is increase.

Castor oil was used as a lubricant where it prevent the elevation of the temperature and decrease the friction between the instrument and the walls of the canals that may affect the cyclic fatigue resistance of the NiTi rotary instruments during the root canal instrumentation which is in agreement with studies done by Gana et al[16] and Baumgart et al[17] showed that the friction reduction ability of castor oil is quite better than that of the formulated commercial mineral oil and this means that Castor oil has superior oiliness and is able to adhere to surfaces of high temperature components of high performance engine, Also there is another study that showed that castor oil could be used as bio-lubricant in mechanical elements which are subjected to high friction[18] where it is demonstrated biocompatibility and antimicrobial activity on Gram-positive bacteria and yeasts[19], smear layer removal, antifungal activity, lubricant, anti-inflammatory and analgesic properties [5, 7, 8] otherwise NaOCl which is non-biocompatible and affect dentin microhardness or EDTA which is not antimicrobial and affect dentin microhardness[20].

Castor oil is diluted by adding ethyl alcohol to reduce the viscosity due its very high solubility in ethyl alcohol and this leads to a lower melting point[86] and better oxidation stability[21].

Aqueous EDTA was showed the highest incidence rate of fracture and this may be attributed to the effect of lubrication where when the viscosity of the oil is too low, a liquid oil film cannot be maintained between two moving surfaces leading to less lubrication effect of aqueous EDTA and this is in agreement with study of Anderson et al.[22]who conducted that lubrication with more viscous solution as RC-Prep can reduced the stress on the instruments and give better results than aqueous solution which have low viscous solutions.

Castor oil 80% and Castor oil 90% showed no incidence rate of fracture in compared to other groups and this may be due to their reasonable viscosity that lead to decreasing the

coefficient of friction and consequently decreasing the exerted force on rotary instrument and this will resulting in lower fracture rate

Castor oil 100% showed fracture rate which may be attributed to the high viscosity of it where its viscosity is about 7 times higher than other vegetable oils[23] which lead to oxidative instability, hydrolytic instability and low temperature properties [24] and this is in agreement with studies of Peters et al.[25] and Shantiaee Y et al[26] who conducted that the high viscous lubricant as RC-prep was less efficient in compared with aqueous EDTA which lead to formation of stable calcium complexes dentin mud, smear layers or calcified deposits, but not in normal dentin. As a result, the force exerted on files will decrease and the rate of fracture will decrease,However, when the paste-like form of RC-Prep is mixed with dentin debris in canals, a thicker mud is formed, causing higher friction rate with dentin walls.

The incidence rate of fracture was size-dependent, in which TS2 has the higher rate of fracture than TS1. This rate could be attributable to the TS2 dimension, because it has the largest size and a greater taper, and thus, is subjected to more intra-canal stresses that increase the rate of fracture.

The incidence rate of unwinding in TS1 was higher than it in TS2 and this may be due to narrowing and curvature of the canal despite proper establishment of a glide path that lead to more force on the apical part of the rotary file .

The instruments fractured because of cyclic fatigue rather than torsional fatigue. To interpret this result, we must bear in mind that molar teeth differ in dentin hardness, internal diameter, and degree of curvature and all of these factors are important in inducing cyclic fatigue.

The results of this study showed that the larger files did not fracture from torsion and this is agreement with other study that showed that increasing in instrument diameter could contribute to an increased resistance to torsional failure, but also to a decrease in resistance to flexural fatigue failure which need high torque to fracture [4].

In the present study, surface detetioration of 2Shape rotary files TS1 and TS2 showed no significant difference in the baseline measurements between the 4 groups.

Conclusions: Within the limitations of this study, it can be concluded that the moderate viscosity of Castor oil was the best during root canal preparation where it decrease coefficient of friction and decrease the incidence rate of fracture while high viscosity is not beneficial during root canal preparation because it increase exerted force on rotary NiTi instrument.

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