Recibido: 19/03/2020 Aceptado: 20/07/2020
DOI: 10.22370/asd.2020.1.2.2415

RESEARCH ARTICLE

ASD JOURNAL Applied Sciences in Dentistry

IN VITRO DETERMINATION OF MINIMUM LENGTH PENETRATION OF A 27G MONOJECT NEEDLE TO IRRIGATE THE MAIN CANAL, AVOIDING EXTRUSION.

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ABSTRACT

Objective: To determine the minimum length penetration required of a monoject27G needle to irrigate the main canal, avoiding extrusion.

Materials and methods: 52 teeth were used, decoronated and worked at equal lengths at a MAF 40. They were randomly assembled in 3 molds and irrigated with diluted Omnipaque. Central trend values were calculated using descriptive statistics. Barlett, Shapiro Wilk and ANOVA one-way tests were applied to analyze statistically significant differences. Subsequently the logistic regression of Oswell-Lemeshow was calculated to look for causality between variables.

Results: Statistically significant results show that at higher needle penetration, the probability of extrusion is greater; regarding minimal length penetration to prevent extrusion, the safest length to irrigate is working length (WL) -4mm.

Conclusions: The minimum length penetration to irrigate preventing extrusion is WL-4 mm.

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KEYWORDS:

Endodontic irrigation; sodium hypochlorite; extrusion; endodontic treatment; endodontic.

Appli Sci Dent Vol. 1(2); 10-25
DOI: 10.22370/asd.2020.1.2.2415

INTRODUCTION

Cleaning and shaping are the most important goals in endodontic treatment; however, it has been proved that there is a 35% of untreated root areas inaccessible to mechanical instrumentation. To achieve the optimal cleansing of remaining tissues and bacterial biofilms, the root canal must be shaped so it can allow an effective flow of irrigating solutions, without damaging periapical tissues.[1,2]

Nowadays, the most used irrigating solution is sodium hypochlorite (NAOCl), although reports of its toxicity on soft tissue is well known.[3] Using NAOCl implies, inherently, an accident risk during treatment. Extrusion to the periapical tissue might be one of those, causing severe pain and tissue edema, that could extend to lips, cheeks, and the infraorbital region. In addition, there is a possibility of secondary infection or the dissemination of a pre-existent one.

A recent poll showed that almost half of all endodontists inquired (42%) in the United States had experienced at least one NaOCl related accident during their professional practice.[4]

To know an optimal penetration length of the needle of endodontic syringes may help to minimize the risks of clinical actions.

This study aims to determine in-vitro the minimum length penetration required of a monoject 27G needle to irrigate the main canal (using sodium hypochlorite), avoiding extrusion. As hypothesis, it was solved that the minimal length required is a WL -2mm.

MATERIALS AND METHODS

The design of this study was a double-blind, random cluster in vitro experimental analytical type.

Apical extrusion is considered an undesired event during clinical procedure, it provokes pain and damage to the patients, which violates the non-maleficence bioethical principle, so this study was conducted in-vitro.

The sample was composed of extracted tooth of patients of the School of dentistry of the University of Valparaíso, with an indication for tooth extraction, from June to July of 2017. The patients were asked to sign an informed consent to participate in this study.

The inclusion criteria were: single rooted permanent and mature teeth, both maxillary and mandibulary, with straight canals, of patients over 18 years old with decision-making abilities and an indication for tooth extraction, regardless of prior systemic health issues.

Exclusion criteria were: crown-root length minor to 15 mm, internal root resorption, apicoectomised teeth, calcified or atresia-compromised root canals, previously treated teeth, teeth with an Initial Apical File over #30 and severely curved canals according to Schneider's classification (1971).

The variables of the study were: needle penetration (independent variable) measured in millimeters, and apical extrusion (dependant variable) measured in its occurrence with a yes/no.

The sample size of this study for each group was 13 teeth, this number was obtained by a hypothesis contrast calculation for two means. In total, there were 4 groups, so the total number of teeth studied was 52.

Finally, the sample obtained was of 52 maxillary teeth that fulfilled the inclusion criteria. In the first instance, each tooth was disinfected and partially de-crowned with a steel disc using low-speed creating a cut transversal to the tooth mayor axis, at the pulp chamber. Using this method a 15mm working length was obtained in every case. In those cases where the working length was lost due to excessive cutting, it was reestablished using the restorative adhesive technique.

Later, the apexes were sealed with wax, allowing its biomechanical preparation. K-files (Dentsply Maillefer) were used with Roanne's balanced forces technique until a #40 MAF (master apical file) was reached, lastly the final irrigating protocol of the University of Valparaíso was used.[5]

Each tooth was placed with a 2x2mm pH paper in

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its apical foramen, formwork in 5mm pink wax, and filled 10mm with cast and sawdust, obtaining a stable structure.

Once all units were included and executed by the standards set, all teeth were aleatorily assigned to the monoject27G's length that they would be irrigated at, conforming 4 groups: circle group (WL-1mm); square group (WL-2mm); cross group (WL-3mm) and triangle group (WL-4mm). After the lengths were assigned, new randomization was performed to determine each teeth position inside the matrices, in three of them, two of 17 teeth (matrix B and C) and one of 18 (matrix A).

As the irrigating agent, an iohexol contrast medium diluted in a 300 mg/ml solution was selected to equalize the viscosity of sodium hypochlorite.

Corresponding millimeters to each length were fixed with a rubber bumper attached to each needle, marked with its corresponding symbol. 1mml of the irrigating solution was used for each tooth, using a Monoject Endo 27 G handled by a third blind operator.

Extrusion measurement was carried on by a blind operator through optic microscopic of the pH paper, this allowed to observe whether there were any pH changes, indicating any extrusion of the contrast medium. Results were recorded in a simple incidence spreadsheet.

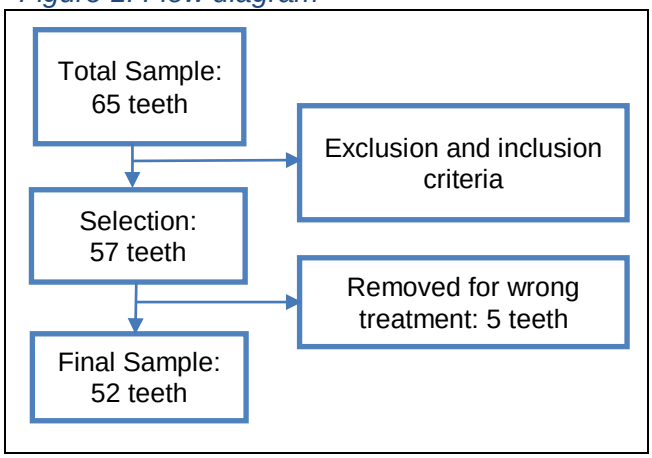
Collected data was automatically placed into Microsoft Excel 2010 by the Python software, obtaining a database. Later, this was complemented with data obtained with the microscope.

With this base, central tendency values were calculated using descriptive statistics. Then, Barlett Shapiro Wilk and one-way ANOVA test were applied to analyze statistically significant differences. Then, Post-hoc analysis of Tukey's test and Scheffe's test were used to evidentiate which groups presented differences. Oswell-Lemeshow regression logistic was calculated to look for any causalities between variables.

RESULTS

52 teeth were used; in the Figure 1, it is shown how the final sample was reached. (Figure 1)

Figure 1: Flow diagram



When evaluating teeth posterior irrigation, there were 11 extrusion cases observed in the WL-1 group, 5 cases in the WL-2 group, and 1 case in the WL-3, resulting in a total of 17 extrusions. There were not any extrusions in the WL-4 group.

By submitting the data of the extruded and non-extruded groups to one way ANOVA, there are statistically significant differences found in each group (non-extruded group p-value=0.00; extruded group p-value=0.0006). Post-hoc analysis of the non-extruded group revealed that the WL-4 group presented statistically significant differences when compared to all other irrigating groups.

Applying a logistic regression model with needle penetration and extrusion as variables, statistically significant results are obtained. (Table I)

When analyzing data through ROC curve, it is inferred that the experimental model serves to predict 80.9% of extrusion cases.
From the ROC curve, the model predicts that as the penetration of the needle into the conduct decreases, the range of extrusion probability decreases.
When analyzing data through ROC curve, it is inferred that the experimental model serves to predict 80.9% of extrusion cases. (Figure 2)
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the penetration of the needle into the conduct decreases, the range of extrusion probability decreases. (Figure 3)

Table I. Oswell Lemeshow logistic regression for Penetration-Extrusion variable.

Penetration	Odds Ratio	Standard Error	P value	95% confidence interval
WL-2	.1136364	.1087536	.023	.0174137 .7415560
WL-3	.0330579	.0359377	.002	.0039257 .2783737
				Pron>chi2 .0008 – Pseudo R2 .2635

Figure 2. ROC curve

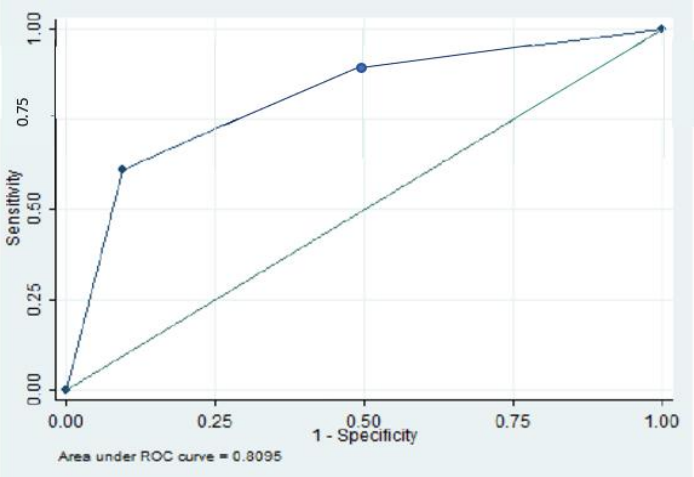
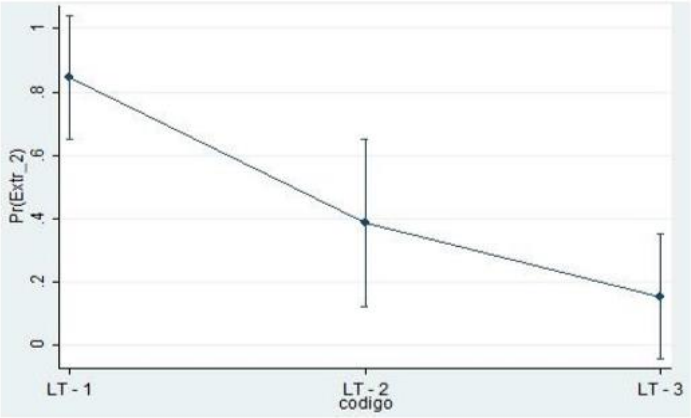


Figure 3. Probability of extrusion per group of needle penetration.



**LT = WL*

DISCUSSION

According to our findings, the higher the needle penetration, the higher is the probability of extrusion, being WL-4mm the safest length for irrigating since it did not present any positive case of extrusion. This response is explained by the location of the bubbles generated inside the canal. E.E Zukoski (1966) evidences the presence of the vapor lock effect with the bubble in an intimate relationship with the total wall, preventing the passage of liquid: in these cases, there would be no extrusion. The bubble may also not contact 100% of the canal surface, allowing the irrigating flow towards the apex.[6] This is the probable situation for those cases where there was a positive extrusion.

According to Boutsioukis et al. (2013), as the needle is closer to the apex there is an increase in the pressure exerted by the liquid with an increase in the probability of extrusion: the results are consistent with this statement, added to the air lock factor that does not obliterate the canal.[7, 8]

The work with freshly extracted teeth made it possible to reproduce, as closely as possible, a real clinical condition as to what it is the superficial energy present in a root canal. In regards to periapical tissue and its simulation, this study used an in vitro mounting configuration similar to those used in previous investigations[9]. This consisted of extracted human teeth with its root submerged into wax and cast, simulating periapical tissues, and thus creating a closed working system that has been endorsed in the literature.[10, 11, 12] However, the mounting structure used in this study was standardized in a way that all samples were equally affected. Besides, the development of a contrast medium with similar viscosity to sodium hypochlorite allows equating its physical characteristics, eliminating errors attributable to the instrument.

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On the other hand, the diameter of the root canal ensures a bigger width than that of a monoject 27G, that is, the obliteration at the time of downloading the medium is not a factor to consider, added to the fact that the tip has a lateral discharge that reduces the probability of extrusion.

One of the limitations of this study is when extrapolating its results to an in vivo scenario. The adverse reaction to the extrusion of sodium hypochlorite, and its sequelae, make randomized controlled clinical trials unethical unless chemically inert irrigants are used.[13] Also, a common limitation, both in this and others, in vitro studies[14, 15] is that it is unknown whether the resistance exerted by the materials is greater, less than or equal to that exerted by periapical tissues in vivo.

In addition, it is necessary to consider the variation that exists among files used in Biomechanical Preparation (BMP). It's of our knowledge that files used in this study are #40 with a 0.2 taper and ±0.02mm tolerance (ADA specification N°20), for that reason the diameter can vary ±0.02 mm between one file # 40 and another, depending on its fabrication and cannot be handled in any clinical nor experimental level; If we consider that our study performed 52 BMP and used 13 different #40 files, there is a high variety in the diameters of the prepared ducts that cannot be objectified. Even if this variety might be millimetric, it directly influences when comparing flow dynamics in two conduits that were prepared by different files of the same number, since according to Ohm's Law, if the diameter of a duct increases twice, the flow increases 16 times, reaching important differences in the resistance.

Besides, the model of this study does not evaluate the sodium hypochlorite extrusion during the treatment, since only extrusion posterior irrigation was measured. According to Hulsmann et al (2009)[16], the extrusion of the irrigant can clinically occur in small amounts during instrumentalization of the root canal, independently of the type of instrument and technique of preparation, not being limited to the moment of irrigation.

To this, we reckon that the adverse effects of sodium hypochlorite have been evaluated in the literature dependant of different concentrations[17,18] but further studies are necessary that relate this effect with the amount of irrigant extruded, allowing to establish in what degree adverse effects are volume dependant and what is the minimal amount that could generate symptoms and physical signs.

Considering that our study detects the presence of extrusion but not its volume, we suggest that further studies are conducted on this topic using extrusion as a quantitative variable, thus being able to determine if the volumes of extruded hypochlorite have significance from the clinical point of view, and to what extent the volume is attributable to the adverse effects described in the literature.

If we analyze the anatomical variability of the duct system, either in diameter or presence of accessory and/or lateral channels, we can deduce that even when results prove that the presence of extrusion is closely related with needle penetration, there might be other factors such as tolerance among prepared canal roots, offering a variable range of resistance for the same file, keeping in mind the resistance exerted by the periodontal tissues that must be overcome.

CONCLUSION

The initial hypothesis was rejected since as the needle is closer to the apex there is an increase in the pressure exerted by the liquid with an increase in the probability of extrusion. This statement added to the air lock factor that does not obliterate the canal,[17] enables establishing that the minimal length required for irrigation without extrusion is WL-4mm, not WL-2mm.

CONFLICT OF INTEREST.

The authors declare not having any conflict of interest.

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DOI: 10.22370/asd.2020.1.2.2415

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HOW TO CITE THIS ARTICLE

Marchant C, Aguirre F, Márquez E,Tapia M. In vitro determination of Monoject27g minimum length penetration required to irrigate the duct, avoiding extrusion. Appli Sci Dent 2020; 1(2): 20-5
DOI: 10.22370/asd.2020.1.2.2415