EFFICIENCY OF WORKING LENGTH DETECTION AND IRRIGATION DURING PREPARATION OF CURVED ROOT CANALS

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Summary. Curved root canals are a challenge for instrumentation, preparation, irrigation and obturation. The aim of the present study was to find the working length and irrigation efficiency in root canals with curvatures 30º-45º and in root canals with anatomical abnormalities 45º-90º. Sixty-eight human, matured, extracted molars with 201 root canals were included in the study. Molars were placed in three groups in relation to the angle between the root and the axis. The first group of molars – straight – 25º-30º, was the control group, n = 14 teeth – 45 root canals; second group – 25-30º to 45º, n = 22 teeth with 66 root canals; third group – 45º to 90º (n = 31 teeth with 96 root canals). Measurements: mesio-distal buccal size of the chamber in its largest part and both bucco-lingual sizes – the mesio dimension was refered to as L1 and the distal one – as L2. Root canal preparation: extraction of the root pulp with K endofiles number 6, 8, 10, with Step Down and Balance force techniques. Canals length was measured rentgenologically using intraoral radiography, preparation continued after X-ray analysis of the level of penetration of irrigants with contrast solution of diluted Urograffin 66%. Regime of active irrigation: same for all groups with 2 % H_2O_2 and 1% NaOCl and paper points drying. To follow up the results a fourth radiography was used and a second one with Urograffin. The applied criteria for working length and for penetration of the irrigant were as follows: 3 – whole working length, 2-1 mm shorter than the working length, 1-2 mm shorter than the working length and 0 – more than 2 mm shorter than the working length. X-ray – working length detection of molars with root canal curvatures was more accurate, compared with straight roots, due to curved canals in straight roots and inadequate instrumentation. The active irrigation was more efficient in curved root canals, because in straight canals most of the irrigant was lost back in the mouth or

periapically. In straight root canals only moisturizing (Miller pins) the canal could be more effective and less dangerous.

Key words: *endodontics, working length, curved root canals*

INTRODUCTION

Curved root canals are a well known challenge for instrumentation, preparation, irrigation and obturation. Root curvatures with abnormalities over 45º are not investigated from this point of view at all. Iatrogenic errors are often associated with these teeth. In the last 15 years, between 1995 and 2010 only 13 articles are related to this problem, excluding those with extreme methodology as the use of 6, 25% NaOCl .

All published articles are researches from in vitro studies and surprisingly the curvatures are from 20º up to 40º. Teeth with curvatures between 25º and 45º, as we found in our previous studies, are from 16 to 19% of all teeth, and with 45º are more than 1.3%. The number of experimental cases in most of the studies varies between 30 and 135 teeth, where the average numbers are 59-62 [1-14]. In most studies the preparation technique is reported to be Step Down [1-9, 11, 12]. Different instrumentations with hand files and machine rotary files are used [6, 10, 11, 13, 14].

Apical preparation size varies from № 10-25 to № 40-45, in relation to the degree of curvature. In these papers differences are not only seen in the irrigation regimes, but also in the type of medication. NaOCl is used as 2.5% – 4.5% – 5% [3, 7, 10] and in a combination with – EDTA [5, 6]. In all regimes H_2O_2 is used for irrigation. The follow-up methods are X-ray [3], SEM [8], bioluminiscense [7, 9], intraoperative microscopy [2], stereomicroscopy [13], and light microscopy [6].

In most of the cases the results were predictable and in most cases a logical result was obtained from the design of the experiment. Summarizing the results, it could be concluded that the type of preparation is a major factor for the degree of remove of the smear layer and the penetration of irrigants and medicines. The highest efficiency is 70% in one group in one article. In most articles not full penetration of irrigants has been found among curvatures between 30-40º.

The aim of the present study was to find the working length and irrigation efficiency in root canals with curvatures 30º-45º and in root canals with anatomical abnormalities 45º-90º.

MATERIALS AND METHODS

Teeth: Sixty-eight human matured extracted molars with 201 root canals were included in the study. All teeth were from the same geographical region.

Groups: Molars were separated in three groups in relation to the angle between the root and the axis. First group – straight – 25º-30º as a control group, n =

14 teeth with 45 root canals, second group 25-30º to 45º (n = 22 teeth with 66 root canals) and third group – 45º to 90º (n = 31 teeth with 96 root canals).

Measurements: Mesio-distal buccal size of the chamber in its largest part and both bucco-lingual sizes – mesio as L1 and distal as L2, and the average of the two – as L, were measured.

Root canal preparation: Starts with opening of the orifices with manual Orifice Openers and extraction of the root pulp with K endofiles number 6, 8,1 0, with

Step Down and Balance force techniques. Root canal length was measured rentgenologically with K files and the preparation continuous after X-ray analysis of the level of penetration of irrigants with contrast solution of diluted Urograffin 66%.

Regime of active irrigation: Same for all groups with 2 % H2O2 and 1% NaOCl and paper points drying. The aim of root canal preparation was, even in roots with 90º curvatures, the apical stop to be number 20-25, and for the rest of the teeth – 30-40. To follow up the results a fourth radiography was used, as well as a second one with Urograffin. Instrument fractures and canal blockage were registered, too.

X-ray regimes: Dental X-ray unit– Phot – XII (Takara Belmont corp, Japan) and intraoral digital sensor Eva (Dent-X Co.) were used. All radiographies were exposed under the same conditions – exposure settings – 60 kv, 7mA, time 0.04 s, etc.

Irrigation measurements scale: The applied criteria for working length (WL) and for penetration of the irrigant were as follows: 3 – whole working length, 2-1 mm shorter than the working length, 1-2 mm shorter than the working length and 0 – more than 2 mm shorter than the working length. All measurements were performed from one examiner, three times with at least three days intervals in between.

RESULTS

Out of total of 207 root canals, four were not found – 2%. Seven instruments were fractured, 4 in group 2 and 3 in group 3, and none in the control group. In seven canals dentine debries formed intracanal blockages, from them 3 in group 1 – the control group, 1 in group 2 and 3 in group 3.

Table 1. WL and number of samples in the tested groups of upper and lower molars

GROUPS	3 – WL		2WL – 1 mm		1WL – 2 mm		0WL – > 2 mm	
Controls n = 45	26	7	–	–	2	1	5	1
30º to 45º n = 66	42	7	4	7	1	–	3	2
45º to 90º n = 96	42	36	–	–	1	–	6	–

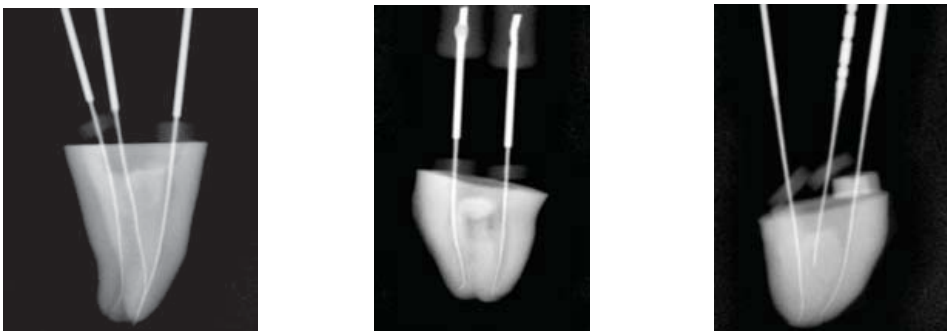
Table 2. Penetration of the irrigant

GROUPS	WL 3-0 mm	WL 2-1 mm	WL 1-2 mm	WL 0<3 mm
Controls n = 45	17	3	–	21
30º to 45º n = 66	43	1	9	13
45º to 90º n = 96	65	9	8	14

As is shown in Table 1 most mistakes are made in the control group, nearly in one third of the cases. This fact can be explained in three different ways. One explanation is the more frequent ramifications, second – the difficulties related to the most accurate choice of the size of the instrument being used, when the teeth are extracted and the third one is the excessive cutting, made more often in straight root canals. In all in vitro studies there was a lack of data on age and sex of the teeth and anthropometrical data. In the experimental groups, this percentage was 10% and 9%, or three times less.

The same trends persisted when irrigants were tested. In the control group, in 50% of the cases, the irrigant was not present in the canal system (Table 2). Still high but lower are the cases of root canals with curvatures, 33% in group 2 and 20% in group 3.

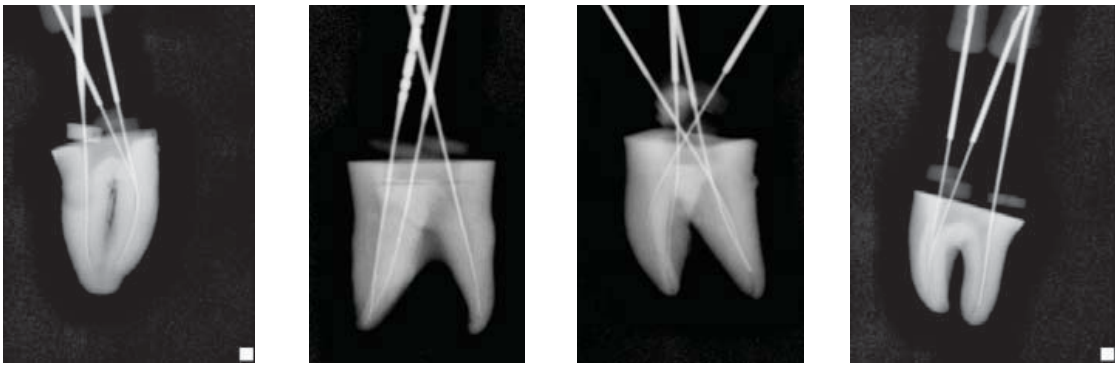
Figures 1-3 show X-rays of canals with irrigant and 7-12 X-rays of WL of different groups.



a) Correct and incorrect working length

b) Correct and incorrect (not sufficient) penetration

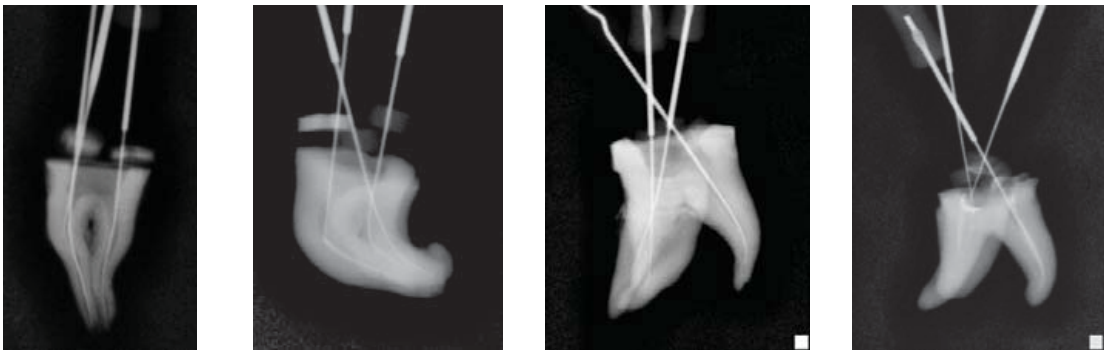
Fig. 1. (a and b) Group 1 Straight root canals



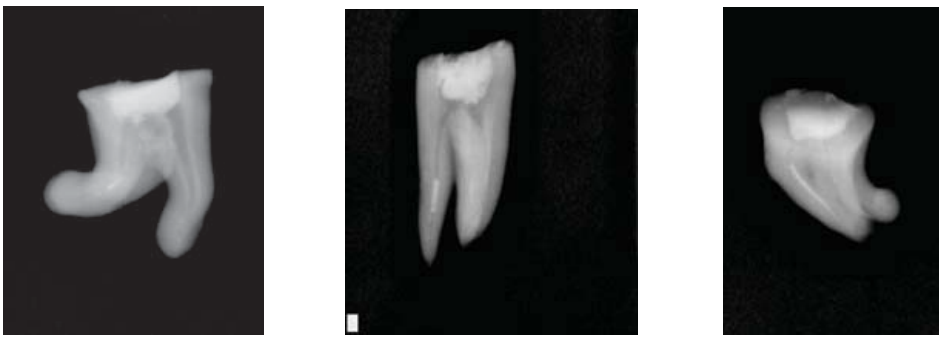
a) Correct and incorrect working length

b) Correct and incorrect penetration of the irrigant

Fig. 2 (a and b) Group 2 – Curved root canals



a) Correct and incorrect WL



b) Correct and incorrect penetration of the irrigant

Fig. 3.(a and b) Group 3 – Root canals with severe curvatures and abnormalities

DISSCUSSION

Under the conditions of this study, designed on the basis of a realistic clinical approach to difficult teeth, it is hard the role of irrigants in root canal preparation to be favoured. In straight canals, especially in young patients, the extrusion of irrigants periapically is more often. In the clinics, this leads to toxic periodontitis and later to chronical periapical lesions.

In curved canals the penetration of irrigants is more difficult, which has its positive and negative trends. Practically, the more severe the curvature is, the more the instrumentation is related to moisturizing the internal root canal surface and to the use of new flexible files with proper sizes. These findings are matching a few other studies [3, 7, 10]. Non-effective irrigation is the irrigation even in curved canals only with 24-28º [7] and 30-33º [3].

Division of teeth in groups of lower and upper teeth in this study was found to be unefficient and without significant differences, even trends and was not found in the literature.

CONCLUSIONS

X-ray WL detection of molars with root canal curvatures is more accurate, compared with straight roots, due to curved canals in straight roots and more often inadequate instrumentation in them.

The active irrigation is more efficient in curved root canals, because in straight canals most of the irrigant is losted back in the mouth or periapically.

In straight root canals only moisturizing (Miller pins) the canal can be more effective and less dangerous.

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