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Wave one® system: clinical experience on 46 cases

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Abstract

Objective: The objective of this study was to evaluate root canal preparation with the Wave One® system as well as single cone endodontic obturation techniques and with staked obturators from the same systePm.

Materials and Methods: 31 patients with 46 teeth and 76 roots canals were included. The roots canals were prepared with Wave One® files and fillled with calibrated cones or stake plugs from the same system. The average times of root canal preparation and filling were measured. The quality of the filling was evaluated by post-operative radiographs according to its limit and density. In addition, errors during shaping and root canal filling were investigated.

Results: The average duration of canal shaping was 9.85. For root canal obturation, the average duration was 6.69 with the single cone technique and 5.55 with the stake system ($p > 0.05$). Concerning the apical limit, the single cone technique had 90.6% of adequate limit and the stake system 83.3% ($p > 0.05$). The single-cone technique showed 7.8% of parietal voids and the stake system 16.6% of parietal and central voids ($p > 0.05$). Finally, no accidents were reported.

Conclusion: This study shows that root canal preparation with Wave One® followed by filling with cones or stake plugs of the same system provides satisfactory results.

Keywords: Root canal obturation, root canal preparation, Wave One®.

Introduction

The endodontic procedure is a complex and delicate procedure on which the periodontal health and the durability of the tooth are based. It is the basis of the dentist's practice and is the essential pillar on which many other disciplines are based.[1] The success of endodontic treatment depends on the shaping, cleaning and filling of the root canal system. The shaping should facilitate the removal of debris and allow irrigation. If the objectives of root canal enforcement are perfectly codified and have remained unchanged since 1974.[2] their implementation, particularly in curved canals, has always been a technical challenge. The use of steel instruments in vertical movement generates problems described in the literature for many years: deviation of the canal trajectory and creation of stops, internal or external transport (tearing) of the foramen, creation of plugs, loss of working length or expulsion of debris in the peri-apical zone.[3-5]

In the mid-1990s, Nickel-Titanium (NiTi) instruments were introduced to the market. These instruments, used in continuous rotation, have allowed the reduction of instrumental sequences, the realization of faster root canal shaping, the respect of the initial trajectory of the canal, less propulsion of debris by the instrument, hence the reduction of the risk of plugging and loss of working length and less expulsion of debris in the peri-apical zone, the improvement of the clinical quality of treatments.[3-6]

The evolution has been made in the direction of simplifying and reducing instrumental sequences. Thus, in recent years, single instrument systems have appeared on the market, which is undeniably attracting interest. At the same time, a new instrumental dynamic has been developed based on the tests carried out by Yared.[7] This movement, called reciprocity movement, corresponds to the concept of balanced forces introduced by Roane.[8] The novelty consists in animating a rotating Titanium Nickel instrument with a movement alternating the clockwise and counter-clockwise direction with different rotation angles.[4-9] In February 2011 a system allowing a single-instrumental preparation using the reciprocity movement was launched on the market: the Wave One® system (Dentsply Maillefer, Ballaigues, Switzerland).[5]

The three-dimensional sealing of the root canal system is the result of endodontic treatment. Its purpose is to seal as tightly as possible all exit doors from the root canal system to the periodontium. Thus, the Wave One® system offers gutta cones corresponding to the root canal shaping instrument. These gutta percha cones, in addition to their apical adaptation, have increased conicities allowing their use for the single cone technique adjusted in size and conicity.[10] Wave One® also offers tutor-mounted shutters, Wave One® shutters.

Thus, the objectives of this study were to evaluate the single instrumental root canal preparation with the Wave One® system as well as the single cone

endodontic obturation techniques and with the tutor obturators of the same system in terms of time, limit, density and safety.

Materials and Methods

This was a cross-sectional descriptive study of patients whose endodontic management began or continued between February and September 2017. This clinical trial was carried out in the Department of Odontology of the Faculty of Medicine, Pharmacy and Odontology of Dakar. The study was approved by the Ethics Committee of the Ministry of Health of Senegal.

They were included in this study all patients giving their informed consent and having one or more mature, mono or pluriradiculated permanent teeth with an indication for endodontic treatment or requiring endodontic retreatment. It was not included; any tooth with terminal bone lysis, immature permanent teeth and patients with a high risk of infection.

Root canal treatments were recorded on clinical cards. They included: patient registration date, record number, patient identification section, endodontic treatment section with: tooth type and location, surgical incidents, duration of root canal shaping and filling, immediate postoperative radiographic evaluation criteria for root canal filling (length and density).

All teeth underwent root canal treatment according to a well-established protocol and by the same operator. Patients were registered only once and in the order in which they presented themselves. For each patient, the teeth were numbered. If several teeth were treated in the same patient, each treated tooth was considered a new case. The operative sequence was as follows: a preoperative radiographic image in orthocentric incidence was taken in the case of a monoradicular or eccentric tooth if it was a bi or pluriradicular tooth. After local and/or regional loco and/or local anesthesia followed by surgical site placement, direct coronary access was established. After determining the working length, using the IPEX electronic apex locator (NSK, Nakanishi, Japan) and irrigation with 2.5% sodium hypochlorite (NaOCl), the canal was manually pre-stretched using a K10 file (#10 K-file, Dentsply Maillefer, Ballaigues, Switzerland). The Wave One® Primary instrument was mounted on the reduction contra-angle and the motor was switched on in reciprocity mode. After irrigation with 2.5% sodium hypochlorite (NaOCl), the instrument was introduced into the canal and ticked slightly back and forth vertically. After 2 or 3 back and forth movements or as soon as a blocking sensation was felt, the instrument was cleaned after removal and the canal irrigated again. The amplitude of the movement should not exceed 3 mm. A back and forth movement is equivalent to a pecking motion. After each passage of the instrument, the canal was irrigated abundantly and the canal permeability was checked with a K10 file. The instrument coils were frequently cleaned with an alcohol-soaked compress to maintain maximum cutting efficiency and to facilitate the removal of debris. The canal shaping was then continued until the working length was reached. A rinse with an ethylene-diamine-tetracetic (EDTA) solution (Dentaflux, Algete, Spain) was followed by a final rinse with hypochlorite before drying the canal with sterile paper cones packaged in "blisters".

The root canal filling was performed using two techniques.

Single cone root technique using Wave One® calibrated cones: Wave One® cones were soaked in sodium hypochlorite before use. Once the canal dried, we deposited sealing cement in the canal using a paste filling and then a calibrated Wave One® cone was inserted into the canal at the working length. A radiographic inspection was carried out to ensure the quality of the endodontic treatment performed before cutting the cone.

Root canal filling with Wave One® obturators: the Wave One® obturator was soaked in sodium hypochlorite before use. Once the canal dried, the dried obturator was heated in the Thermaprep Plus® oven. We placed a drop of cement root canal at the entrance of the canal to be sealed with a paste filling. The obturator was then inserted into the canal in an apical, linear and slow but firm and continuous movement. Once the working length was reached, the pressure was maintained for 5 to 7 seconds to compensate for the retraction of the grip of the guttta percha at cooling. The obturator was then cut without spray with the Therma-Cut® cutter at high speed. Once finished, a vertical compaction of the softened gutta-percha around the stake finished the filling. Radiographic inspection was required to ensure the quality of the endodontic treatment performed.

The average preparation time was measured with a stopwatch in minutes and seconds. The duration in minutes was retained in the study, knowing that each minute started was counted. The stopwatch was activated after anaesthesia and damming in cases of vital pulp. In cases of necrotic pulp, it is activated after the rubber dam has been laid. The stopwatch was then activated after drying the canal and stopped after the root canal filling, before taking the post-operative radiograph.

Pre-, per- and post-operative radiographs were performed using the parallel plane technique using Kodak Ultra-speed D films (Care Stream Health, Inc., Rochester, NY, USA). They were mounted in a cardboard slot to prevent ambient light from entering the illuminated observation box (Star X-ray illuminator, Star X-ray illuminator, Star X-ray illuminator, Amityville, NY, USA) and examined at a magnification of 2 × with a magnifying glass.

The quality of the filling was evaluated by canal from post-operative radiographs according to the limit of the filling in relation to the radiographic apex, the

density of the filling with or without voids. These criteria were observed on retro alveolar, orthocentric or eccentric radiographic images. The length of each closed canal was categorized as adequate (0-2 mm less than the apex), under and over filling depending on its relationship to the radiographic apex. The density of the filling was evaluated according to whether or not there were voids in the blocked canal. In addition, the presence of procedural errors, such as tearing and transporting the apex, perforation and instrument fractures were investigated. The radiographic evaluation was performed independently by two endodontists. In the event of disagreement, the two observers had reached a consensus.

Data are analyzed with the SPSS software version 2.0. Qualitative variables are described by number and percentage and quantitative variables by mean and standard deviation. The comparison between the two root canal filling techniques was made with the Kruskal Wallis test; the significance threshold was set at $p < 0.05$

Table 1: Average duration of root canal preparation (in minutes per tooth)

	5 to 6	6 to 8	8 to 10	10 to 12	12 to 14	14 to 16	16 and more	Total
N	3	15	8	3	4	1	12	46
%	6.5	32.6	17.4	6.5	8.7	2.2	26.1	100

Table 2: Average duration of root canal filling according to the technique (in minutes per tooth)

Techniques	Time	4 to 5	5 to 6	6 to 7	7 to 8	10 to 11	15 and more	Total
Single cone	N	5	11	3	9	7	1	36
	%	13.9	30.6	8.3	25	19.4	2.8	78.3
Wave One obturator	N	6	3	0	1	0	0	10
	%	60	30	0	10	0	0	21.7
Total	N	11	14	3	10	7	1	46
	%	24	30.5	6.5	21.7	15.2	2.1	100

Table 3: The quality of the root canal filling according to the limit (per canal)

Techniques	Apical limit	Cemento-Dentine junction	Radiological Apex	Under obturation	Over Obturation	Total
Single cone	N	33	25	6	0	64
	%	51.5	39.1	9.4	0	84.2
Wave One obturator	N	3	7	1	1	12
	%	25	58.3	8.3	8.3	15.8
Total	N	36	32	7	1	76
	%	47.4	42.1	9.2	1.3	100

Table 4: The quality of the root canal filling according to the density (per canal)

Techniques	Apical limit	Parietal and central voids	Central Voids	Homogeneous	Total
Single cone	N	0	5	59	64
	%	0	7.8	92.2	84.2
Wave One obturator	N	1	1	10	12
	%	8.3	8.3	83.4	15.8
Total	N	1	6	69	76
	%	1.3	7.9	90.8	100

Results

We have identified 31 patients, 15 male and 16 female. At the maxilla, the treated teeth were: 5 central incisors (10.9%), 2 lateral incisors (4.3%), 3 canines (6.5%), 4 first and 7 second premolars (23.9%), 2 first and 1 second molars (6.5%). In total, 24 maxillary teeth were prepared and filled, representing 52.1% of the sample. At the mandible, the treated teeth were 2 central incisors (4.3%), 3 lateral incisors (6.5%), 2 canines (4.3%), 2 first and 4 second premolars (13%), 5 first and 4 second molars (19.8%). In total, 47.9% of the sample are mandibular teeth (22 teeth). In the end, 46 teeth with 76 canals were included in the study.

The average duration of root canal shaping was 9.85 ± 4.20 (Table 1). For root canal filling, the average duration was 6.69 ± 2.45 with the Wave One® cone sealing technique and 5.55 ± 3.11 with the obturator system (Table 2). The difference in duration between the two root canal techniques is not statistically significant ($p > 0.05$).

The study showed that the apical limit of the single cone technique was the cemento-dentine junction in 51.5% of the canals and in 39.1% of the radiological apex, or 90.6% at the Apical Safety Limit. The technique with the staked obturators had presented the cemento-dentinary junction in 25% of the canals and the radiographic apex as the apical limit in 58.3% of cases, or 83.3% at the Apical Safety Limit. Only one apical exceedance case was identified with the obturator system (Table 3). The difference between the two root canal techniques according to the apical limit is not statistically significant ($p > 0.05$).

The density was assessed taking into account the presence or absence of central and/or parietal avoids. The Wave One® single cone technique showed 7.8% parietal avoids. The Wave One® obturator technique had 16.6% of wall and central avoids (Table 4). The difference between the two root canal filling techniques according to density is not statistically significant ($p > 0.05$).

Finally, no accidents involving tearing and transporting apexes, root canal stops and perforations or instrument fractures were observed.

Discussion

The success of endodontic treatment depends on the shaping, cleaning and filling of the root canal system. The shaping must promote the removal of debris and allow irrigation and root canal filling to perpetuate the results obtained during this cleaning and shaping phase. In recent years, the evolution in endodontics has been towards simplifying and reducing instrumental sequences.

In this study, with an average time of about 10 minutes, root canal preparation was rapid with the Wave One® system. A maximum time of 18 minutes was recorded for one endodontic retreatment case. Burklein in its comparative study on the preparation capacity and cleaning efficiency of Reciproc® and Wave One® versus MTwo® and Pro Taper®, also described a significant reduction in preparation time through the use of Wave One®.[12] In addition, other studies on the subject[7,11,13,14,15,16] have shown that reciprocal instruments offer a shorter shaping time than continuous rotation systems. This can have a technical explanation. Wave One instruments have an inverted helix. The particular design of these instruments enables them to do the cutting action in counterclockwise direction more significantly than clockwise[5] thereby facilitating progression in an apical direction.

In this study, the recorded time included the instrumentation phase but also the time required to clean the instrument turns and for irrigation. The preparation time depends on the surgical technique, the root canal anatomy and the experience of the operator. Endodontic treatment usually lasts between 45 minutes and 1 hour. The time saved in the chair with only one instrument is therefore appreciable. However, it should be kept in mind that the instrumentation does the setting and that irrigation cleans and disinfects the canal. Thus, the time saved during the shaping process must be used in conjunction with abundant and regular irrigation in order to eliminate as much as possible the smear layer.[17] The current consensus on irrigation time is that it lasts at least 10 minutes of contact time to eliminate as many bacteria as possible. Bukiet emphasizes the optimization of the quality of endodontic treatment with a longer irrigation time with the new single instrument systems.[18]

The average duration of 5.55 minutes for the root canal filling by the Wave One® obturators shows its simplicity and effectiveness as described in other studies.[19-25] The single cone technique with Wave One® cones took relatively longer with an average of 6.69 minutes but this difference is not statistically significant. However, it is a clinically satisfactory technique without additional costs compared to inputs (no furnace required and less expensive cones).

The apical boundary was assessed using four landmarks: the cemento-dentinary junction at about 1 mm from the radiographic apex, the radiographic apex, the under filling (more than 2 mm below the radiographic apex) and the over filling (projection of gutta cones and/or sealing cement beyond the apical foramen). This study showed that for both techniques, the rates of reaching the apical safety limit are appreciable (90.6% and 83.3% respectively) compared to Thermafil® under the same clinical conditions.[23] Cemento-dentinal junction and radiographic apex being considered as the apical safety limit according to Delzangles.[26] The use of electronic apex locators that determine the working length with greater precision and speed, combined with the use of radiography instruments in place, have certainly allowed these results. According to Friedman[27] the extrusion of filling materials in the peri apex usually leads to a poor prognosis which would result in superinfection and periapical inoculation. These often precede the protrusion of the root canal filling material. The health of the periapical region is directly related to the overall quality of endodontic treatment.[28-30]

The density evaluation showed that both filling techniques had significant density rates (92.2% with cone sealing and 83.4% with stake plugs). These results are comparable to those of Leye-Benoist[23] with the Thermafil® technique (92.7% of canals). These results show that the single cone technique with Wave One® cone provides good homogeneity, which justifies the three-dimensional nature of this root canal filling technique.[31] The Wave One® obturator system has a particular ability to seal the lateral canals and dentine tubules, thus increasing the hermeticity of the filling. Maalouf et al[24] stipulate that the obturator system gives a better density to the radiography compared to other filling techniques using gutta percha, which is in

accordance with our results. Filling of the internal resorption at the palatal root of a maxillary molar attested to the three-dimensionality of the obturators technique.

Finally, no accidents involving tearing and transporting apexes, root canal stops and perforations or instrument fractures were observed. This reflects the safety provided by the Wave® One system and the root canal filling techniques used, as highlighted in previous studies.[12,15,31,32] Reciprocating instruments benefit from the qualities of the NiTi M-Wire alloy which is produced through a method of treatment of a NiTi wire by subjecting it to cycles of temperature change. This method increases the resistance to fracture.[15]

Conclusion

During this study, it appears that root canal preparation with Wave One® followed by filling with cones or obturators of the same system allows the practitioner to perform endodontic treatments much more easily, with an enormous time saving and a significant reduction in accidents on the way. This contribution of Wave One® increases the durability of endodontic treatment.

However, the ease and especially the speed allowed by this shaping technique must not obscure the importance of irrigation, which alone will allow the disinfection and cleaning of the canal system before sealing it. The time saved on shaping should be used to allow more irrigation of the apical area.

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