EC DENTAL SCIENCE
Case Series

An Innovative Sequence for Endodontic Treatment: Endostar E3 Azure®

Sonia Zouiten[1,4]*, Hana Bougatef[3,4], Faten Khanfir[2,4], Mohamed Tlili[2,4], Mohamed Salah El Khalfi[1,2], Nabiha Douki[1,2] and Faten Ben Amor[1,2]

[1]*Professor at the Monastir Faculty of Medicine and Dentistry, Tunisia*

[2]*University Hospital Assistant at the Monastir Faculty of Medicine and Dentistry, Tunisia*

[3]*Post Graduate Student, Department of Restorative Dentistry-Endodontics, Faculty of Dental Medicine, Monastir, Tunisia*

[4]*Research Laboratory of Oral Health and Rehabilitation, LR12ES11, Faculty of Dental medicine, Monastir, Tunisia*

***Corresponding Author:** Sonia Zouiten, Professor at the Monastir Faculty of Medicine and Dentistry, Tunisia.

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Abstract

Introduction: The main objective of endodontic treatment is chemo-mechanical root canals debridement. The use of nickel titanium (NiTi) systems alloy provides an easy and fast canal preparation. However, it is often associated with the risk of instrument separation. For this reason, manufactories are always trying to improve the physical and mechanical properties of the alloy using different thermal and surface treatments.

Aim: The aim of this paper was to describe two clinical cases treated with an innovative endodontic nickel-titanium system (Endostar E3 Azure® system) and to detail its use instructions.

Conclusion: Endostar E3 Azure® seems to be helpful in the treatment of the majority of root canals, especially the narrow or curved ones with low risk of file separation. Respect of the clinical protocol guarantees predictable good results.

Keywords: *Root Canal Shaping; Nickel-Titanium Alloy; Endostar E3 Azure®; Thermal Treatment*

Introduction

The goal of endodontic treatment is to achieve an ideal biomechanical root preparation while maintaining the original shape of the root canal system without any procedural accidents [20].

It is well-known that a straight root with a straight canal is an exception rather than a common finding. The common causes of endodontic treatment failure in cases of atypical canal anatomies are the result of procedural errors, such as ledge formation, fractured instruments, canal blockage, zipping, or elbow creation [13].

During the past few years, various types of rotary nickel-titanium systems have been designed with different tip designs, tapers, cutting blade configuration and alloy treatment to improve flexibility and cleaning efficiency during root canal preparation [14]. Endostar E3 Azure® system is one of these systems.

In fact, manufacturers have introduced several thermally-treated NiTi alloys to improve the transformation behavior and the mechanical proprieties of endodontic instruments, such as flexibility, fatigue resistance, cutting efficiency and canal-centering ability [7], having in turn greater influence on the endodontic treatment quality.

System description

Endostar E3 Azure® is an innovative system created using Azure HT Technology by Poldent. It is a specially designed heat-treatment manufacturing process. The goal of Azure HT Technology was to create files that are extremely flexible and resistant to breaking, even in the most complicated clinical cases. The files can easily fit even the strongly curved canals, thus minimizing the risk of canal perforation.

Main features (Figure 1)

- **Taper**: Taper value is codified by the number of stripes on the handle:
    - 1 stripe → 8%
    - 2 stripes → 6%
    - 3 stripes → 4%.
- **Diameter**: It is codified by color stripes respecting ISO size. 20, 25, 30, 35, 40, 45.
- **Section**: It conditions the overall profile of the instrument. The blade profile corresponds to the types of blades in contact with the canal wall. The central part is called residual mass, mass central or central core. It corresponds to the instrumental section without its peripheral part [6].

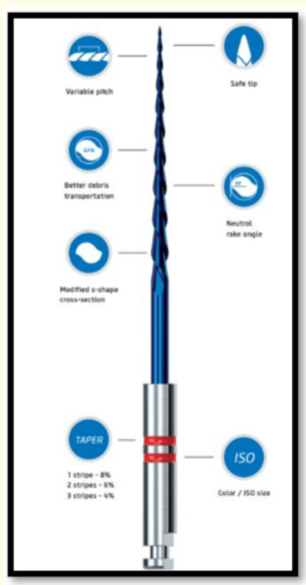

Figure 1: *Endostar Azure® features.*

The central mass conditions both flexibility and resistance to fracture.

The modified S shape of the file with two 90-degree cutting edges ensures efficient cutting, transports debris out from the canal and decreases the preparation time.

Rake angle

The angle is formed, on the one hand, by the intersection of the tangent to the surface of the front part of the instrument blade and on the other hand, by the radius, passing through the edge of the circle in the instrument [6,16].

This angle, also called angle of attack, determines the way the chip is formed on the face cut. It can be positive, neutral, or negative. Endostar E3 Azure® has a neutral rake angle. The cut is perpendicular to the channel wall and the instrument acts by scraping the dentin surface.

Pitch

The apparent pitch is the distance between two successive turns on the working part of the instrument. It is generally variable within the same instrument [23].

Endostar E3 Azure® has a variable pitch.

Tip

The tip might be sharp or round, respectively active or passive. The inactive tip of Endostar E3 Azure® allows safe preparation, thus minimizing the risk of via falsa, perforations and zipping [24].

Alloy treatment: The Azure HT Technology process modifies the crystal structure of the nickel-titanium files. It allows the transformation of martensite to austenite occurring at a near body temperature.

According to the manufacturer, this process completely changes the files properties. The files can be pre-bent before being inserted into the canal. They can easily follow even the most curved canal path with a minimal risk of perforation, ledges or via falsa.

In root canal treatment (at body temperature), the instrument benefits from both the martensitic and austenitic phases (Figure 2).

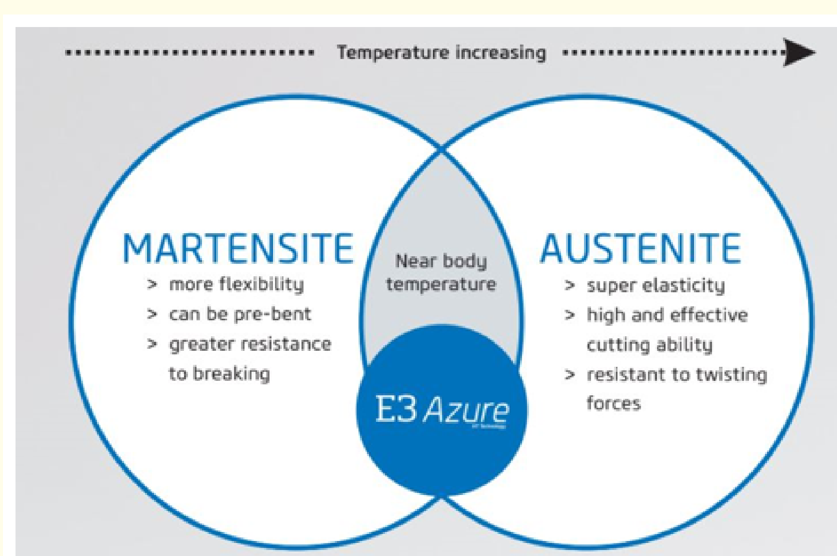

Figure 2: *Endostar Azure® alloy phases.*

Endostar E3 Azure® contains 3 sequences

An instrument set is composed of 3 files. The taper and the diameter can be identified respectively through the number of stripes on the handle and color stripes (ISO size), enabling effortless use of the instruments.

Endostar E3 Azure® basic: It is indicated for normal width and straight or slightly curved canals (Figure 3):

- File N°1: 8% 30
- File N°2: 6% 25
- File N°3: 4% 30.

Endostar E3 Azure® big: It is not a separate rotary system. It is an extension of the Endostar E3 Azure® Basic and it is used for shaping wide canals for which final preparation to size 30 is not sufficient. It should always be preceded by an initial preparation performed with the Endostar E3 Azure® Basic (Figure 4):

- File N°1: 4% 35
- File N°2: 4% 40
- File N°3: 4% 45.

Endostar E3 Azure® small: It is not a separate rotary system. It is an extension of the Endostar E3 Azure® Basic designed for use in very narrow and curved canals. The canal should be first shaped using Endostar E3 Azure® Basic files (Figure 5):

- File N°1: 6% 20
- File N°2: 4% 25
- File N°3: 4% 20.

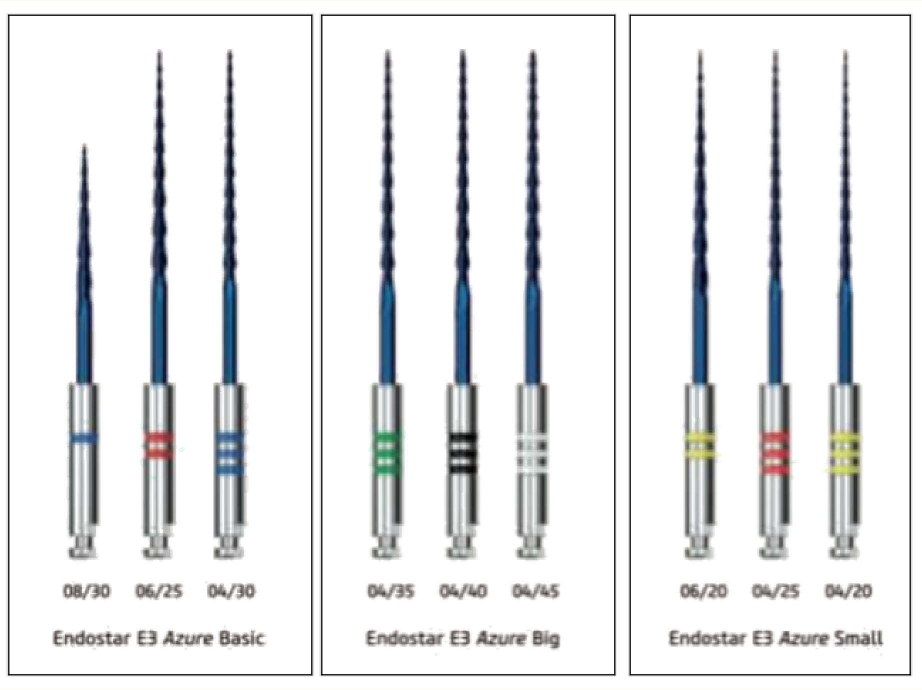

Figure 3-5: *Endostar E3 Azure® basic Endostar E3 Azure® big Endostar E3 Azure® small.*

Principles of use

Recommended movements

Endostar E3 Azure® was designed for 3 common types of motion to achieve a perfect root canal preparation.

Rotary motion

The instruments rotate clockwise (CW - clock wise) with a set speed between 150 - 300 rpm with up-and-down motion.

Reciprocal motion

The instruments perform alternating clockwise (CW) and counter clockwise (CCW) movements. The clockwise angle (CW) rotation must be larger than the counter clockwise rotation (CCW), for example 90 degrees CW and 30 degrees CCW.

Complex motion

It combines the rotary and reciprocal motion. The files rotate until reaching a too high resistance in the canal. Then, the reciprocal mode is activated (CW - CCW, net CW). The rotation mode is turned on again once it is activated (CW - CCW, net CW). The rotation mode is turned on again when resistance returns to an acceptable level.

Recommended torque

The torque settings are indicated in the table above (Table).

Agents	Dosing	Administration	Side Effects
Dextrose	4 - 8 mg/kg/min	Continuous infusion	
Glucagon	Bolus: 200 mcg/kg 1 mg/day	Intermittent infusion Continuous infusion	Hyponatremia, thrombocytopenia
Glucocorticoids			Growth suppression, hypertension
Dexamethasone	0.25 m/kg 1 - 2.5 mg/kg/dose	IV once every 12hr IV once every 6hr	
Hydrocortisone	50 mg/m^2/day		
Nifedipine	Initial: 0.25 - 0.3 mg/kg/day Final: 0.5 - 0.8 mg/kg/day	Orally once in every 8hr	None reported
Octreotide	7 - 12 mcg/kg/day	Subcutaneous every 4 - 6hrs	Cholelithiasis
Diazoxide	10 - 15 mg/kg/day	Orally once every 8hr	Hirsutism, heart failure, fluid retention, nausea, vomiting.

Table 1: *Pharmacological agents used in the treatment of neonatal hypoglycemia [12].*

Do not exceed the upper torque limit which is different for each instrument. If precise torque settings cannot be set, and only manufacturer-specific torque levels are available, be sure to select one that does not exceed the recommended limit.

Use protocol

The standard sequence basic with straight roots is as follows (Figure 6):

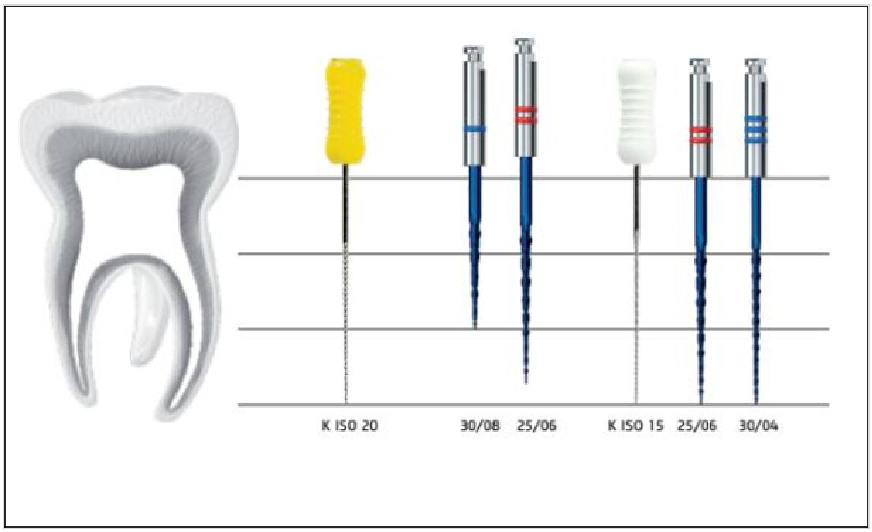

Figure 6: *The standard sequence basic with straight roots.*

1. Prepare the cavity and locate all the canal orifices, lubricate the canals.
2. Specify the working length of the canal using your method of choice.
3. Prepare the canal with hand instruments.
4. Continue to shape the root canal with hand files up to size 20. This way, you will create a glide path for rotary instruments. This will also reduce the risk of breaking the rotary file.
5. Prepare the upper part of the root canal: Shape the canal orifice with the Endostar E3 Azure® Basic File No. 1 (08/30) until you reach a maximum of 1/2 of the total canal depth.
6. Prepare the middle part of the root canal: Start working with file No. 2 (06/25). Perform up-and-down movements. Shape the canal up to 2/3 of the working length. Inspect the working length with size 15 hand file and apex locator. Next, insert file No. 2 at full working length.
7. Shape the apical part of the root canal: Use file No. 3 (04/30) to widen the apical portion of the canal until full working length is reached. Confirm that full working length is reached with hand file size 15 and apex locator. Next, finish working with a nickel-titanium hand file size 30. Check if the file can be inserted at full working length without obstructions, and if wedging can be felt.

If a wider preparation of the apex is needed, continue to work with larger hand instruments size 35, 40 etc. or consider using the Endostar E3 Azure® Big.

For wide root canals: Endostar E3 Azure® Big sequence (Figure 7)

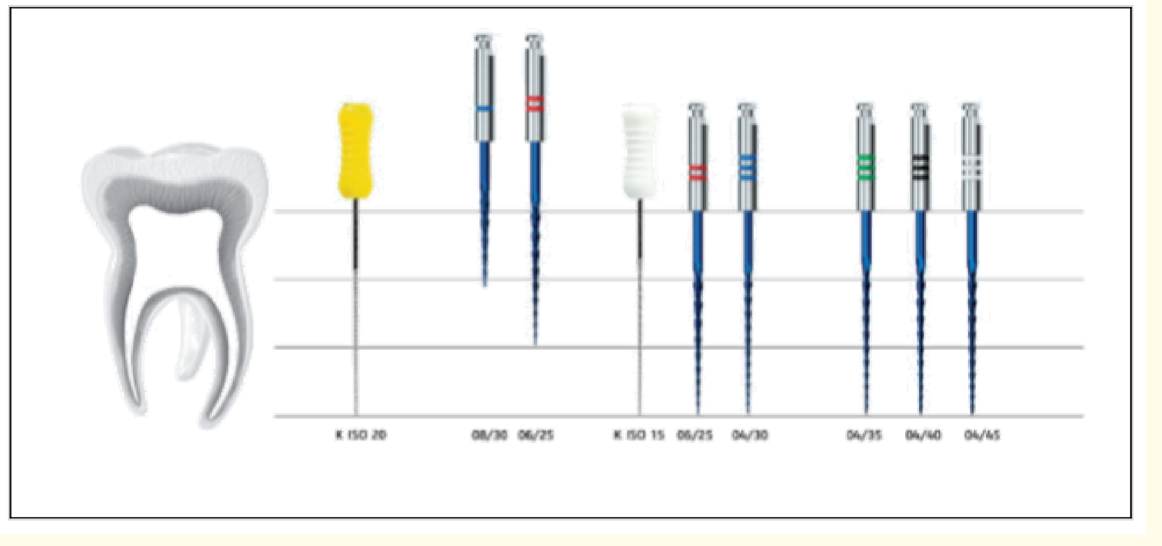

Figure 7: *Endostar E3 Azure® Big sequence.*

After preparing the canal using file No. 3 from the set of Endostar E3 Azure® Basic, shape the canal with instrument No. 1 from the Endostar E3 Azure® Big (04/35) until full working length is reached. Finish with hand NiTi file size 35 for gauging.

Insert this hand file at the working length (vertical movement without rotation). If you feel a slight resistance to further movement of the file at the working length, this means that preparation can be finished on size 04/35. If you feel that the file does not encounter resistance at the working length, it is advisable to expand the canal with the next larger sized file from Endostar E3 Azure® Big and so on until you reach the adequate preparation.

For narrow or curved root canals: Endostar E3 Azure® small sequence (Figure 8):

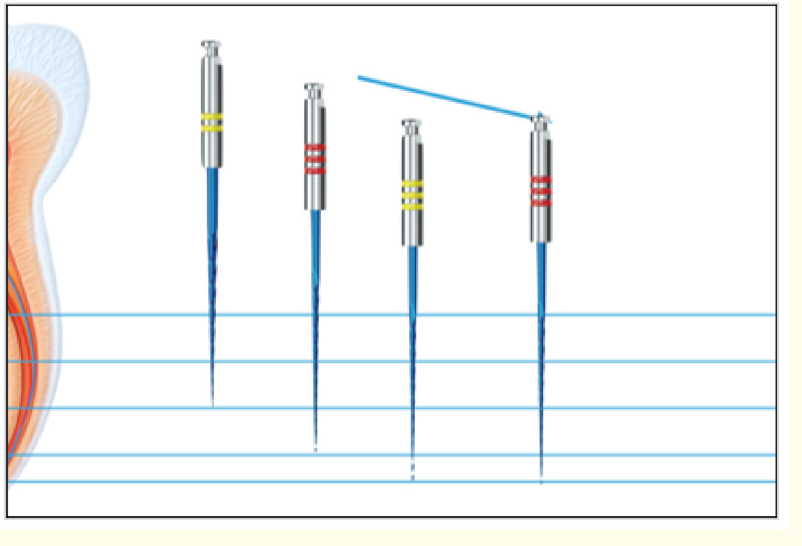

Figure 8: *Endostar E3 Azure® small sequence.*

1. Prepare the cavity, locate the orifices and specify the working length of the canal with 10 K file.
2. Prepare the upper part of the root canal: preflaring: Shape the canal orifice using the Endostar E3 Azure® Basic No. 1 (08/30) file until delicate resistance is detectable. Do not apply excessive force to the instrument, especially in highly curved canals.
3. Use a rotary Glide path with NiTi Two® (poldent) (15/02, 02/20 depending on the case) at the working length.
4. Prepare the middle portion of the root canal: Start working with file No. 2 from the Endostar E3 Azure® Basic (06/25). Perform up and down movements. Work to a maximum of 1/2 the working length.
5. Shape the apical part of the root canal.
6. Using file No. 1 from the Endostar E3 Azure® Small (06/20), shape the canal a few millimeters down. Do not force the instrument down the canal. Take file No. 2 (04/25) and continue to shape the canal. Stop working at 2 mm before reaching full working length. Use file No. 3 (04/20) until full working length is reached. File No. 3 (04/20) allows shaping even in very narrow and extremely curved canals. Next, go back to file No. 2 (04/25) and use it until full working length is reached.
7. Widen the root canal: After checking the apical width with the NiTi file, consider widening the canal with file No. 3, which is part of the Endostar E3Azure® Basic (04/30) set. Skip this step in extremely curved canals and finish shaping at size 04/25.

For all the sequences we should not forget the two golden rules following each file use: an abundant sodium hypochlorite irrigation and hand file n° 10 recapitulation.

Recommended number of use

Endostar E3 Azure® instruments can be repeatedly sterilized and used, provided that the dentist's visual inspection prior to their use shows that they are undamaged, not bent, or deformed, they do not show signs of blade wear and can be securely attached to the hand-piece. Particular attention should be paid to the files winding (or excessive twisting).

The instrument windings should be regularly spread over the entire length of the blade. If the windings are too close or too far apart at one point of the blade (no regularity in the windings growth of the unused instrument), this is a sign that the instrument could break in the canal.

Permanent deformations of the instrument, especially the bends, which do not have the form of an arc and have a visible break point should always be controlled before re-use. The heat-treated NiTi alloy allows these instruments to bend in the form of an arc.

In case of doubt, the file can be placed in any environment (fluid, air) at a temperature slightly above 40^{0}C for a few seconds. Then, the blade should be straightened or curved on a very smooth arc. If the file is still deformed, it means it is permanently deformed and could not be used again. After each use, check that the blade is securely placed in the file grip. If the file has been subjected to high torsion force, especially in highly curved canals, the instrument should be used only once.

Clinical Cases

Case no 1

A 33-year-old female patient presented to our department with spontaneous severe pain in the lower left posterior teeth. Clinical examination revealed an open access cavity with exposed cotton and a defective distal amalgam restoration in the mandibular first left molar. The tooth was tender to axial percussion.

The patient reported having severe pain before and that he had visited a private dental practitioner for treatment.

Radiographic examination revealed widening of the periodontal ligament space with a small periapical lesion appended to both the mesial and distal roots (Figure 9).

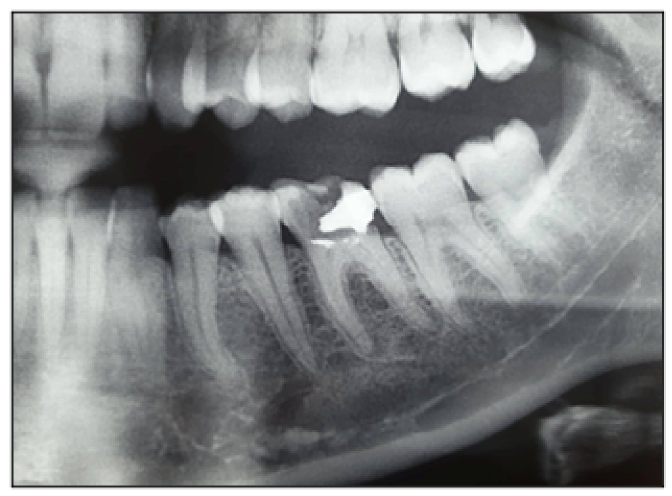

Figure 9: *Preoperative radiograph (orthopantomogramme).*

Acute apical periodontitis was diagnosed.

The access opening previously performed in the private clinic was modified and disinfected with sodium hypochlorite 2.5%, with root canals relocation after rubber dam isolation and coronal pre-building with conventional glass ionomer. Three canals were negotiated with prebent 10 K file NIC® lubricated with EDTA (Ethylenediaminetetraacetic acid) gel (MM-EDTA Cream Micro Mega®). The working length of each canal was determined using apex locator and it was confirmed using periapical radiograph (Figure 10).

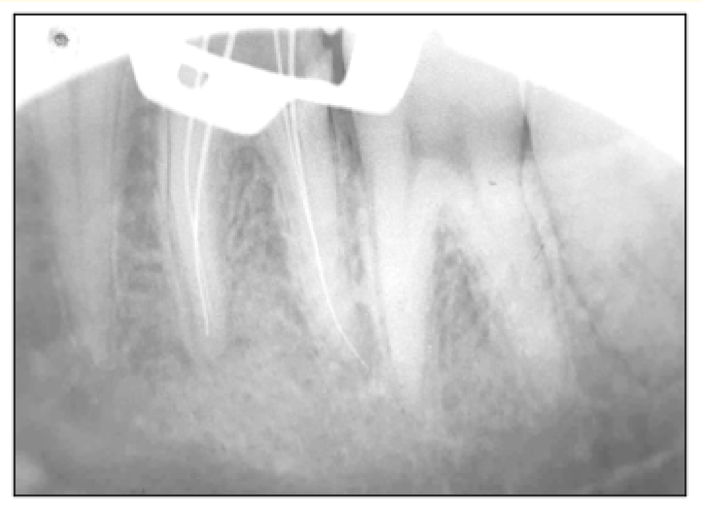

Figure 10: *Peroperative periapical radiograph: working length etermination.*

Manual negociation was carried out until k file 20 NIC®. Then, a rotary Glide path was insured using NiTi Two® file taper 2 size 20 (Poldent). Special attention was given to frequent irrigation of the root canal and recapitulation with 10 K file.

As for the coronal part preparation, we shaped the canal orifice with Endostar E3 Azure® Basic File No. 1 (08/30) until reaching 1/3 of the total canal depth in this case.

For the middle part preparation, we used file No. 2 (06/25) with up-and-down movements until reaching 2/3 of the working length without excessive force. Inspection of the working length with size 15 hand file and apex locator is crucial. Next, we completed the preparation with the same file No. 2 at full working length.

Regarding the apical part shaping, file No. 3 (04/30) was used to widen the apical portion of the canal until full working length was reached.

Canal disinfection was carried out using calcium hydroxide $Ca(OH)_2$ and the tooth was temporary restored. At the one-week follow-up, the tooth was asymptomatic. The temporary restoration was removed, and $Ca(OH)_2$ dressing was irrigated. The final irrigation sequence was carried out as follows: 17% EDTA (Ethylenediaminetetraacetic acid) solution (Micro Mega®) with well-adapted master gutta percha cone and manual dynamic activation during 1 minute. Then, neutralization with normal saline solution, and final irrigation with sodium hypochlorite 2.5% activated with the same manual technique were performed. Finally, the canal space was dried with paper point.

The root canals were filled using lateral condensation technique with zinc oxide-eugenol as sealer.

A final postoperative radiograph was taken (Figure 11). The patient was referred for total prosthetic covering.

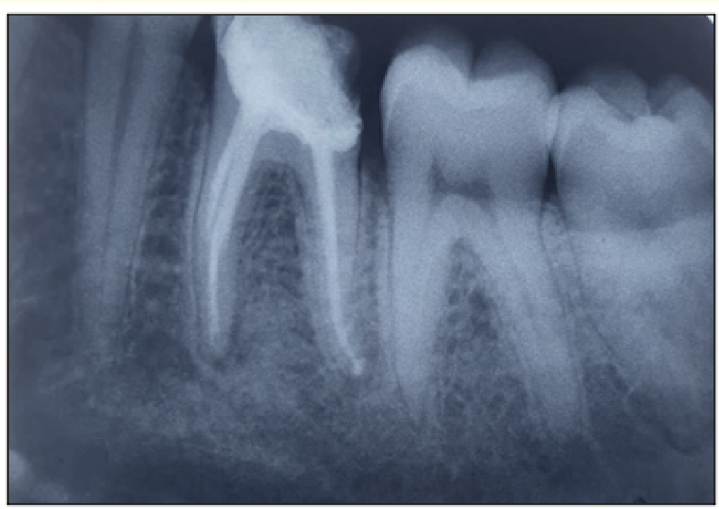

Figure 11: *Postoperative radiograph.*

Patient was recall for radiographic control after 12 months (Figure 12).

Figure 12: *Radiographic control after 12 months.*

Case no 2

A 53-year-old female patient presented to our department with dull aching pain in the lower left posterior tooth persisting for few days. Clinical examination revealed deep carious lesion on the mandibular left first molar with loss of coronal tooth structure associated with a pulp exposed carious lesion on the second premolar. Radiographic examination revealed caries extension to the pulp along with widening of the periodontal ligament space around the root with a periapical lesion and an external apical root resorption (Figure 13). Chronic periodontitis was diagnosed.

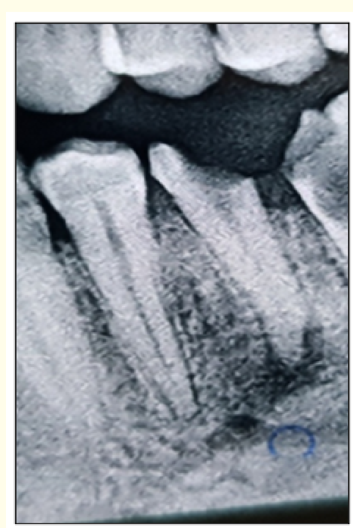

Figure 13: *Preoperative periapical radiograph.*

An access opening was made after rubber dam isolation and coronal pre-building. Manual negotiation of one located central root canal was carried out with prebent 10 K NIC® file lubricated with EDTA gel (MM-EDTA Cream Micro Mega®). The working length was determined using apex locator and it was confirmed using a radiograph.

The canal was thoroughly irrigated using sodium hypochlorite between the use of each instrument. The manual glide path was finished until k file 20 NIC® with abundant sodium hypochlorite 2.5% irrigation after each file working.

Then, for the coronal part preparation, we shaped the canal orifice using Endostar E3 Azure® Basic File No. 1 (08/30) until reaching 1/2 of the total canal depth in this case.

After that, for the middle part preparation, we used file No. 2 (06/25) with up-and-down movements until reaching 2/3 of the working length. Inspection of the working length with size 15 hand file and apex locator is crucial. Next, we completed preparation with the same file No. 2 at full working length.

As for the apical part shaping, file No. 3 (04/30) was used to widen the apical portion of the canal until full working length was reached. The apical foramina gauging with manual K file n° 30 NIC® indicated no resistance due to the apical foramina resulting from apical resorption. So, a wider preparation of the apex was needed. We continued the work using Endostar E3 Azure® Big with instrument No. 1 (04/35) until full working length was reached. Then, we finished with hand NiTi file size 35 NIC® that provided an apical resistance.

The final irrigation sequence was carried out as follows: 17% EDTA (Ethylenediaminetetraacetic acid) solution (Micro Mega®) with well-adapted master gutta percha cone and manual dynamic activation during 1 minute. Then, neutralization with normal saline solution, and final irrigation with sodium hypochlorite 2.5% activated with the same manual technique were carried out. Finally, the canal space was dried with paper point.

Root canal filling was carried out using EQV system® from Meta Biomed by the continuous wave obturation technique. A postoperative radiograph was taken (Figure 14).

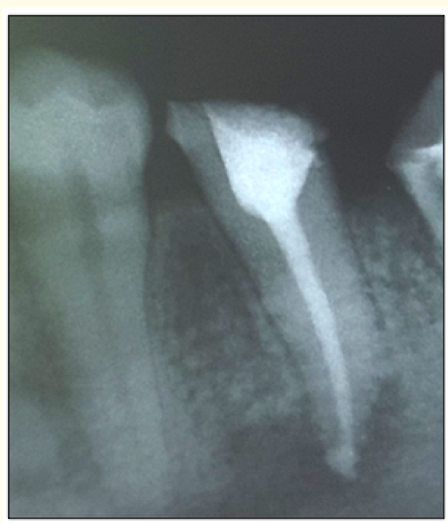

Figure 14: *Postoperative radiograph.*

The patient was referred for total prosthetic covering. A radiographic control after 18 months showed complete healing of the periapical lesion (Figure 15).

Figure 15: *Radiographic control after 18 months.*

For the two cases we adopted continuous rotation. Instruction of use must be respected; the shaping time should be as short as possible in a lubricated root canal with an up-and-down motion, and the instruments as well as the handpieces should be operated according to the manufacturer's instructions (torque settings and speed).

Discussion

Nickel-titanium (NiTi) rotary instruments used daily to provide mechanical cleaning and shaping for root canal treatment are easier and faster than stainless-steel hand files. They have proved to be more likely to improve the clinical success of root canal treatment. However, NiTi rotary files are still perceived to have higher fracture risks [37].

In recent years, endodontic instruments have undergone a series of changes allowing for better debris removal, increased cutting efficiency, better flexibility, and more resistance to separation. These changes include innovations brought about by modifications in design, surface treatments, thermal treatments and incorporation as well as hybridization of new movement strategies to drive the instrumentation systems. In fact, the mechanical performance of NiTi instruments is mainly determined by both the manufacturing processes and the geometric design [15].

These file design features, such as rake angle, helical angle, pitch, taper, and tip design affect both performance and the shaping forces on the root dentin.

Knowing the physico-mechanical characteristics of endodontic instruments as well as their proper mode of use provides greater security and efficiency for the practitioner.

Endostar E3 Azure® is an innovative system created with thermal treated alloy. It is formed by 3 types of sets with different tapers.

An instrument set is composed of 3 files. The taper and the diameter can be identified respectively through the number of stripes on the handle and color stripes (ISO size), enabling effortless use of the instruments.

The large choice of different tapered instruments is a strong point providing a wide use indication.

In fact, in his study, Schrader found that using various instrumentation sequences and different tapers combinations seem to be safer with regard to torsional and fatigue failure. However, they occur the use of a greater number of instruments [28].

Moreover, the cross-sectional design is known to affect stiffness and stress and therefore plays a significant role in file breakage [36,38].

Endostar E3 Azure® presents a modified S shape section file with two 90-degree cutting edges, ensuring efficient cutting, transport of debris out of the canal and a decrease in preparation time according to the manufacturer.

In this context, Schafer., *et al*. compared 5 different system sections (pentagonal, triangular, in S, in U and convex triangular), and found that the triangular and S section systems seem to have the best cutting efficiency [27].

In addition, asymmetric sections also provide better cutting efficiency, debris evacuation and root canal centering [31].

It was also proved that with this section, the cutting edges become closer to each other at the tip of the instrument, allowing a more delicate cutting action in the apical region, a more efficient cutting in the cervical third, a reduction in debris accumulation [4] as well as a decrease in the screwing-in effect. As a result, the file becomes more resistant to torsional breakage and therefore has a longer lifetime [26].

Another important feature is the rake angle. Endostar E3 Azure® has a neutral rake angle. When the face of the blade coincides with the radial line, it is said to be neutral or zero rake angle (planing).

This characteristic is also a part of the instruments working efficiency.

With the diminutive size of endodontic files, it may only be possible to create a neutral or close to neutral rake file system with the nickel-titanium alloy.

Other studies have suggested that positive rake angle increases the cutting efficiency and therefore takes less energy to cut the dentin. However, this causes digging and gouging of the dentin, possibly leading to file separation [5,25].

Endostar E3 Azure® has a variable pitch. The pitch is defined as the number of spirals per unit length on the file or the distance between the corresponding pitch line elements of adjacent flutes in the plane of rotation which can be short, long or variable.

Used in continuous rotation, the pitch has an influence on the flexibility of the instrument. It may also have an impact on the screwing effect.

During rotary root canal preparations, torsional stress and the tendency to screw into the dentin are particularly accentuated using continuously rotating nickel-titanium systems. Certain parameters can be modified to limit file separation and the tendency to screw in [8].

The result of a constant pitch and constant helical angles is a “pulling down” or “sucking down into” the canal [25].

The transverse pitch has a significant impact on the tendency to screw in and torsional stress.

If the stress is too great, the instrument may deform and even break. Rotary file may also screw into the canal if it has a regular pitch and a positive cutting angle [8].

A longer pitch may help prevent the screwing-in. A longer pitch reduces the helical angle, which in turn considerably reduces aspiration.

In their study, Franck Diemer., *et al*. reported that the longer the pitch is, the more effective the instrument will be [8] and the less screwing effect is present.

It is well-known that debris extrusion can occur following all the instrumentation techniques, but some techniques or systems may result in less extrusion than others [35].

In fact, the results of the study conducted by Elham showed that the short pitch design extrudes less debris than the medium and long ones. Short pitch files have more threads along the same length than medium and long pitch files. They have more grooves between the cutting edges to entrap more debris during preparation. They might also reduce the quantity of debris extruded [9].

In previous studies using finite element models to investigate the effect of pitch length, the short pitch is more flexible and has a higher torsional fracture resistance and a lower screw-in effect [2,12,37].

To minimize the negative effects of both short and long pitches, manufacturers have introduced variable pitches and variable helical angles in an attempt to reduce suck-down observed with constant pitch, especially in files that are .06 taper or greater [17].

In conclusion, the files designed with constant tapers but with variable pitches and helical angles results in dramatic reduction in the sense of being "sucked down into" the canal [25].

The file tip is another element that performs the guiding function. The tip might have a sharp or a rounded configuration design. It can be either cutting or non-cutting (Figure 4) [24].

Endostar E3 Azure® has an inactive tip which allows for a safe preparation. It minimizes the risk of file deviation, perforations and zipping. It is less aggressive and less likely to transport the canal [17,19].

Going along with a non-cutting tip will facilitate a good centering in the root canal space and create a concentric circle at the end of the root [25].

However, the cutting tips on the rotary files make them too aggressive. They have the ability to enter narrow and calcified canals, but with less experienced practitioners, they can accidentally cause root transportation or even perforation which is very difficult to repair and obturate [25].

The other important feature is the alloy treatment. Endostar E3 Azure® is a blue instrument machined from a heat treated alloy.

It is well-recognized that sudden fracture of NiTi rotary instruments, especially in curved root canals, is one of the most important endodontic mishaps [22].

To prevent NiTi rotary files fracture, manufacturers are working to improve the cyclic fatigue resistance using different alloys and applying various heat treatments [21].

Previous studies have shown that heat treated instruments are 300 - 800% more resistant to rupture with cyclic fatigue strength 4 - 9 times higher than conventional NiTi [30].

Fortunately, thermal treatment of the alloy is known to produce a better arrangement of the crystal structure, thus theoretically leading to an improved flexibility and strength [18].

Indeed, the conventional NiTi alloy is primarily in the austenite phase at room temperature. Thermomechanical treatments could maintain the alloy in the martensite phase, R-phase, or in a mixed form by altering the transformation temperature, and consequently changing the characteristics of the alloy [30,32].

Thus, several manufacturers have developed special thermomechanical processing in order to produce a superelastic NiTi alloy that primarily contains a stable martensitic phase at room temperature. All the new heat-treated NiTi instruments introduced on the market (i.e. R-Phase NiTi, SybronEndo, Orange, CA; M-Wire, Dentsply Tulsa Dental, Tulsa, OK; and CM Wire, Colt_ene Whaledent, Cuyahoga Falls, OH) have shown better physical and mechanical properties compared to the instruments manufactured with conventional NiTi alloy [39].

Endostar E3 Azure® were introduced by an innovative heat treatment methodology using a unique process that controls the material's memory similarly to the shape memory NiTi rotary files recently introduced into the market.

At body temperature, Endostar E3 Azure® contains both autenitic and martensitic phases.

Actually, heat-treated alloy with stable martensitic phase at body temperature leads to superior mechanical properties, extreme flexibility, better performance and specific properties: superelasticity (the ability to return to its original shape after being deformed) and shape memory effect [11,30,33].

Consequently, the instruments can be pre-bent, which confers greater flexibility and fatigue resistance contributing to a more centered canal preparation and lower transportation rates, especially in cases presenting curved root canals [11].

Moreover, Endostar Azure® (poldent) was introduced to produce NiTi instruments using an innovative and proprietary method called HT technology of NiTi wire processing resulting in a distinctive blue color because of a visible titanium oxide layer [29].

In the NiTi Blue Wire alloy, the thickness of this titanium oxide layer is 60-80 having in turn a great influence on the reliability and mechanical properties of NiTi files, especially on increasing the cutting efficiency and wear resistance [11].

Finally, Endostar E3 Azure® was designed for 3 common motion types to achieve perfect root canal preparation; rotary motion, reciprocal motion and complex motion.

Each movement has advantages and disadvantages.

Actually, most practitioners are accustomed to using continuous rotation.

In fact, the continuous rotary motion provides an increased number of cycles, leading to an increase in the cutting efficiency [10].

On the other hand, some studies have shown that reciprocating motion induces lower tensile and compressive stress in the flexed region of the instrument through the disengagement motion, thus providing greater fatigue resistance when compared to continuous rotary motion [3].

Reciprocating motion seems to cause more debris extrusion into the periapex than the continuous rotation due to its piston effect through the pecking motion [34].

Conclusion

The proliferation of new mechanized systems in endodontics has brought much confusion to this field. However, it is evolving towards safer use with higher flexibility and efficiency. Such a significant increase in material flexibility and resistance to fatigue have allowed better preparation of curved canals and less risk of canal transportation and iatrogenic errors, such as file separation.

Thus, Endostar E3 azure® is paving the way for a generation of instruments with thermal- treated alloy that are useful in treating difficult cases with narrow or curved root canals.

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