Dynamic Navigation in Endodontics

Managing complex root canal anatomy

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About the Author

Dr. FEJOZ Gregory
obtained his dental degree in 2010, at the University of Claude Bernard of Lyon 1, FRANCE.

After 9 years of general practice in Haute-Savoie, not far from Geneva (SWITZERLAND), he specialized in endodontics, following the training of Dr MACHTOU and colleagues at the SOP in Paris.

His current interests include developing an endolight approach by using vital pulp therapy treatments for adults and develops the use of dynamic guided navigation in endodontics.

Introduction

In this recent years, developments in the field of endodontics have made it possible to improve the initial diagnosis and anatomical study, thanks to the CT beam cone (CBCT), surgical precision, thanks to the microscope, and canal shaping, thanks to the heat treatment of rotating files. This combination of means has allowed the development of a minimally invasive approach, from the access cavity to shaping, with tissue preservation as a leitmotiv.

Addressing the problem of root canal obliterations in this spirit remains a challenge. The search for permeability under a microscope is tedious with multiple verifications, due to lack of direct vision. It is also not very reproducible and random from one tooth to another. Finally, tissue loss can be significant, with the risk of creating a false canal or a perforation. A tool was missing to guide the practitioner during the access drilling.

One of the solutions was to adapt the implant surgical static guides to endodontic use. The drilling axis, planned on the CBCT, is defined by a socket present in the guide. Special drills have been developed to meet the needs of endodontics: a small diameter (0.8 - 1mm) and a shape suitable for working in the dentin. Several studies (1-2) have demonstrated the effectiveness of this method but disadvantages are highlighted (3):

- Inability to modify the drilling axis during the intervention, the guide becomes unusable if errors have accumulated in the digital workflow
- Need for a large oral opening to compensate for the thickness of the guide and drills
- Important equipment with a long and incompressible design time

To compensate these shortcomings, another solution has been developed : dynamic navigation system (DNS). This technology comes from general medicine and was applied in implantology in the 2000s. Its use in endodontics has begun to be studied from 2019 (4). Several studies have shown the same effectiveness as static guides, greater precision than by hand, whether in the angle or the preservation of dental tissue. Drilling becomes reproducible but also modifiable during intervention (5,6,7,8).

Requiring only a CBCT is also an advantage to use the DNS unexpectedly.

The learning curve could be long and a significant cost represents the current obstacles to the development of this technique.

Material and Method

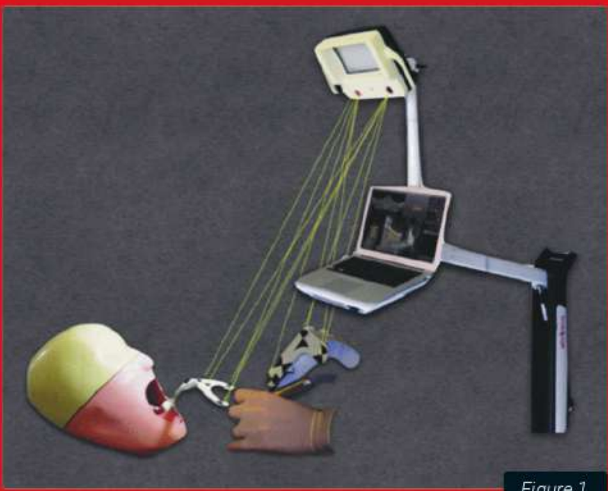

Figure 1

The DNS principle is based on 3 tools :

- The continuous spatial location of a bur or a drill by infrared cameras (Figure1)
- The use of a CBCT to plan access to the calcified canal (Figure 2)
- The use of a tracer to map in real time the oral structures chosen as markers (tooth, thermoplastic support or mini-screws) and make them correspond to the CBCT (Figure3-4).

Figure 2

Figure 3

Tracing is the most important step in the protocol, all the precision of canal access results from it. The system must be able to detect the patient marker + the tracer and the practitioner must point out the chosen structures in strict order. At the end of the registration, an accuracy check is carried out to validate this step. (Figure 5). It is common at the beginning of the use to hide the patient marker, misdirect the tracer or misposition the camera and thus lose the current acquisition.

The handling of the counter-angle and its detection by the cameras modifies the interface, which displays a target materializing the drilling axis and the depth is visible right next to it. The sagittal and transverse axis are also visible. A calibration of the counter-angle and then the bur is done followed by the precision check. (Figure 6). Piezotomes and ultrasonic inserts can also be used in the same way.

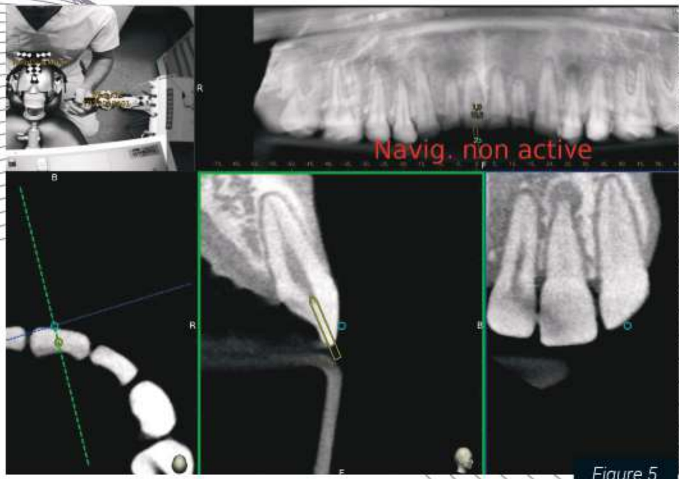

Figure 5

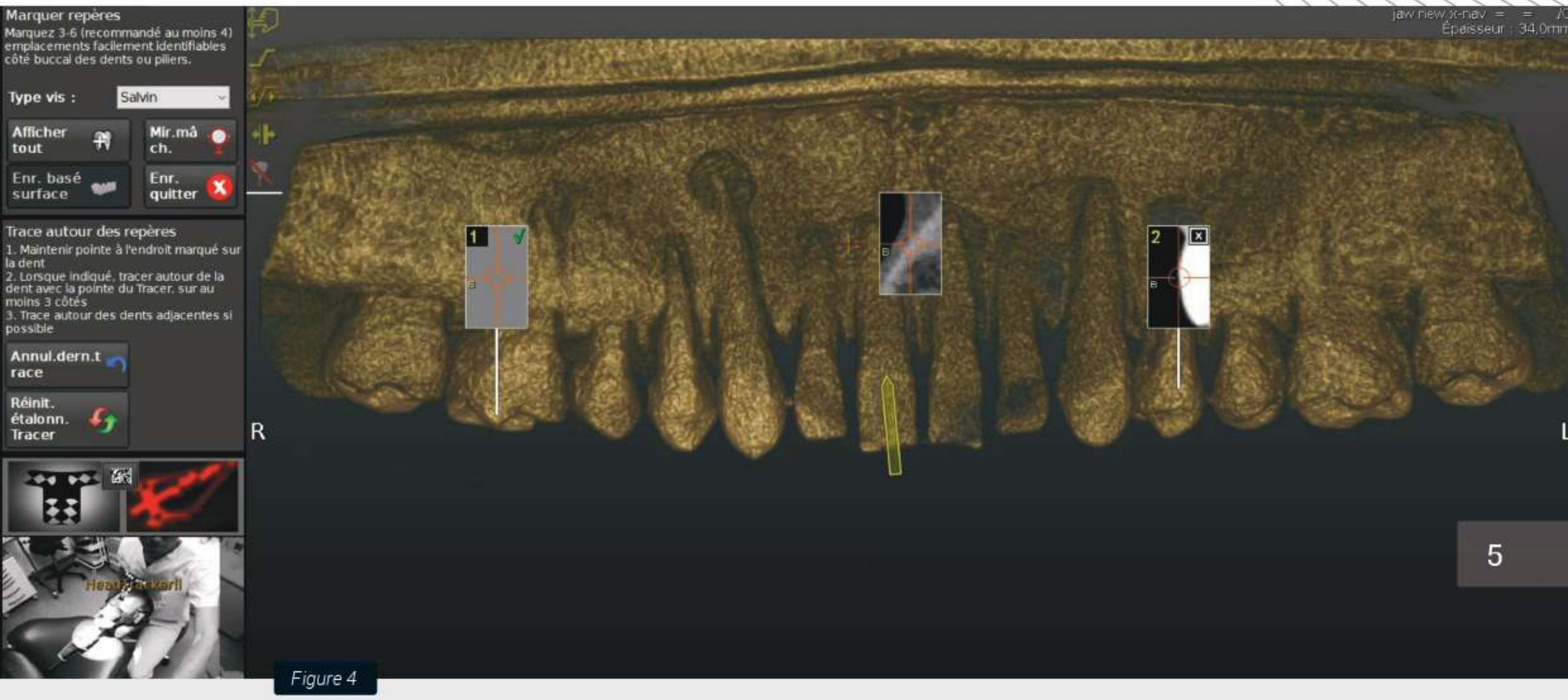

Figure 4

The software is able to distinguish several counter-angle markers, which allows, for example, to continuously alternate the use of low-speed burs mounted on a blue ring counter-angle with high-speed burs mounted on a red ring counter-angle.

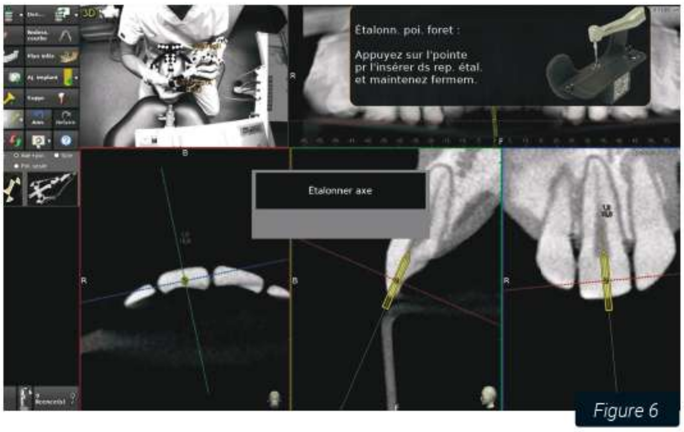

Figure 6

An audible and visual alert informs the practitioner of the achievement of the objective (Figure 7). Once the permeability is confirmed by the passage of a manual file, the complete device (markers and trolley) is removed, for greater comfort, and the endodontic treatment can continue in a conventional way.

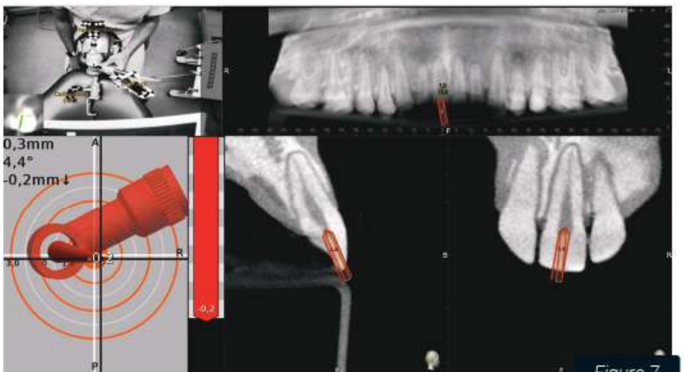

Figure 7

In Vitro Approach

Figure 8

Figure 9

To be able to master the DNS and its different steps, the manufacturer provides a phantom head on which two training models can be installed. The CBCT corresponding to the models are pre-installed and tests can be carried out immediately in the remote areas containing wax. (Figure 8). But these are developed for implantology and there is no endodontic space to go through.

3D printing has progressed considerably and very realistic models have emerged. Those developed by Delendo, called True Jaw Calcified Canals, allow, once installed on a ghost head, to have a reproduction extremely close to the real (Figure 9). The resin used cannot reproduce the hardness of the dentin but these models make it possible to train and get used to indirect drilling to seek permeability.

In our case, the maxillary model allowed us to simulate the future clinical case and work on ergonomics (layout of benchmarks, acquisition of tracing, management of the drilling axis). It is possible to install an operating field with a unit clamp but also in multi-clamp, which was achieved in our case (Figure 10).

Figure 10

The canal access protocol is as follows:

Drilling

Coronary drilling begins with a sterile diamond ball bur on a red counter-angle of the 4 entry points, with the head of the counter-angle held by both hands: this method makes it possible not to skid when entering contact with the tooth and to be able to change the position before entering the tooth in depth. (Figure 11). Coronary access continues with a long-neck sterile diamond ball bur.

Root drilling is carried out with a long tungsten sterile bur on a blue ring counter-angle (EndoTracer, Komet) (Figure 12). This bur, available in 2 lengths (31 - 34mm) and a diameter between 0.4 and 1mm, is suitable for use in guided endodontics. But its non-continuous form, with a gradual enlargement from the average third, can hinder in the event of minimally invasive access. Static guided endodontics drills can be used to solve this problem, such as long neck Steco forest (BioSummer3D). But they do not have great lateral flexibility and can break in case of axis correction.

Figure 11

Figure 12

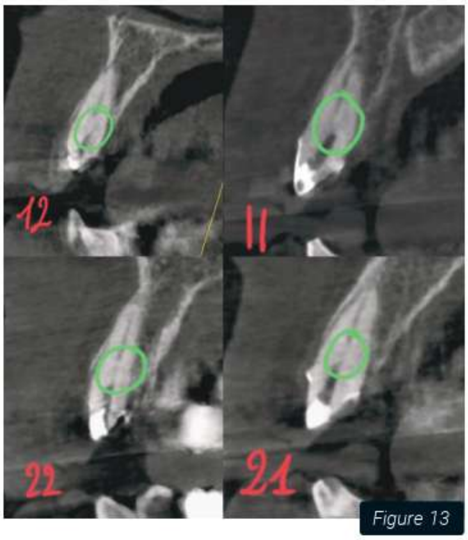

Figure 13

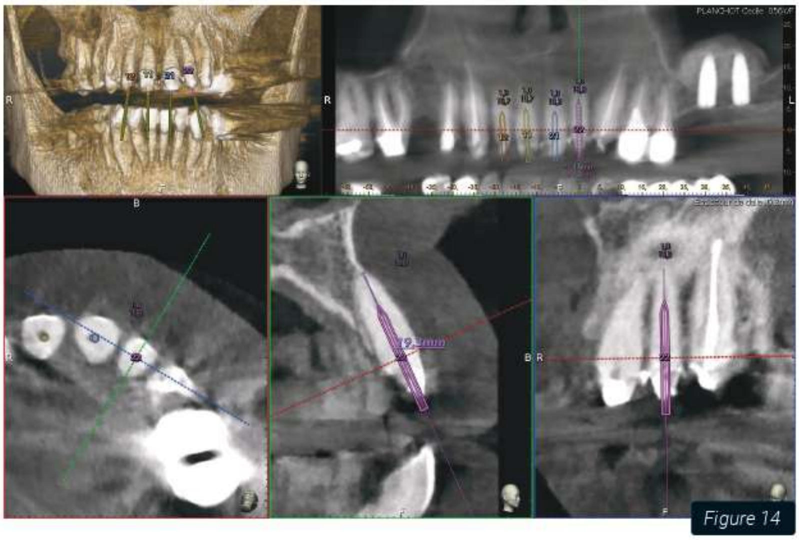

Figure 14

Clinical Case

56-year-old patient, ASA1, referred by his general dentist for the canal treatment of the 4 upper incisors. They are subject to a prosthetic rehabilitation from 23 to 13, with temporary crowns.

The preliminary study at the CBCT showed a canal atypy for 12 and 11, with a 1-2-1 configuration at the average third. The 21 and 22 have a significant narrowing at the same level (Figure 13).

The planning of the 4 access axis is carried out before the appointment, with the visualization of the length of the access (between 13 and 15.5mm), which makes it possible to choose burs and drills accordingly. This length is not exact, the volume of provisional crowns is invisible on the CBCT (Figure 14).

The session begins with the placement of the frontal marker on the patient's head, then she's installed in the chair. The tracing step begins, with the calibration of the tracer and then the acquisition of the structures chosen as oral markers. Once this step is validated, para-apical anesthesia (articaïne 1/200 000) is performed as well as the installation of the rubber dam. It's cut between 23 and 13, because the temporary crowns are welded and the sealing is ensured by Structur (Voco) (Figure 15). The field is disinfected with a compress soaked in sodium hypochlorite for 30 seconds.

The drilling protocol is realized as mentioned above during in-vitro approach.

Ultrasonics of type ET20 or ET25 (Satelec) are used to clean the access well and remove dentinal mud. Microscopic control is used in the middle and at 2/3 of the progression, to visually ensure progression in the calcified dentin.

The permeability is confirmed using a K-file and the operation is repeated on the other 3 incisors. (Figure 16)

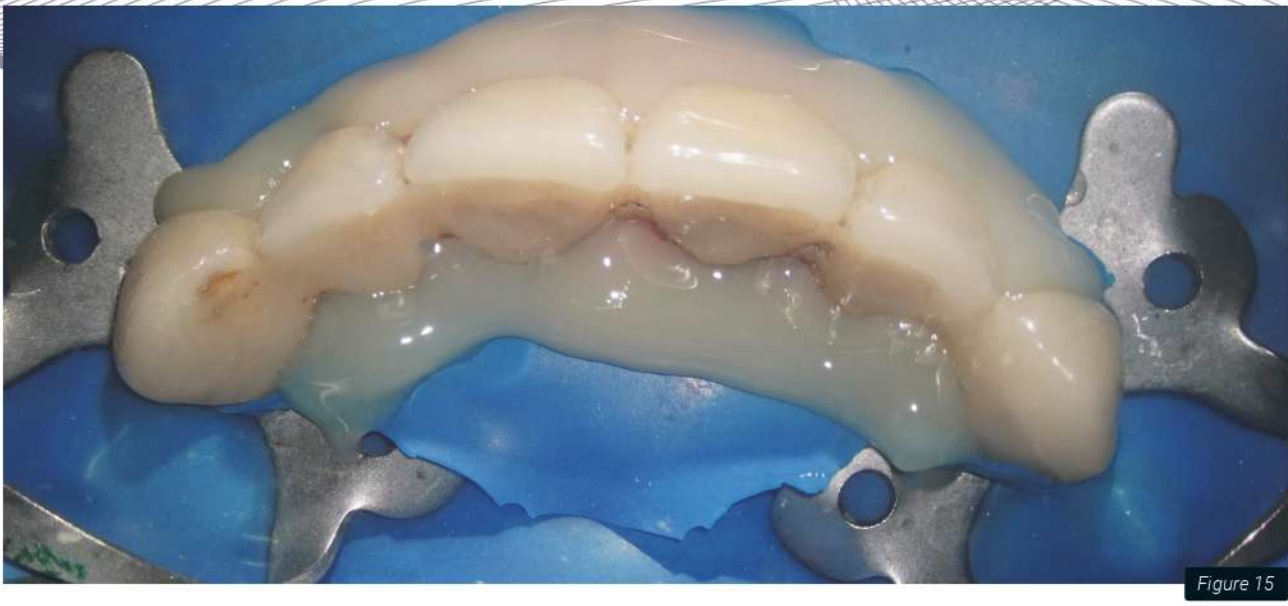

Figure 15

Once the radiographic check with the 4 K-files in place is done, the Navident cart is moved to make place for a deck table containing all the equipment necessary for the shaping and the obturation.

Working lengths are determined (EndoPilot, Komet) and shaping is carried out with 6% heat-treated reciprocity files (Procodile Q, Komet) according to the latest international recommendations: renewed irrigation with sodium hypochlorite 2.5% during the shaping, passage of a K10 permeability file and radiographic control of the gutta-percha cones in place (Figure 17).

This is followed by the EDTA 17% rinsing step (1mL per channel, for 30 seconds) and then the passive sonic activation of sodium hypochlorite at 2.5% (Eddy, VdW, 5mL per channel, for 20 seconds). Gutta-percha cones are disinfected by soaking in sodium hypochlorite for 1 minute and then rinsed with alcohol before being wiped with a sterile compress. The canals are dried with sterile paper tips before being obturated using the vertical wave condensation technique (Gutta-Smart, Dentsply) with zinc-eugenol oxide cement (Sealite, Pierre Roland). A radiographic check follows and a temporary sealing is put in place (Cavit, 3M) (Figure 18).

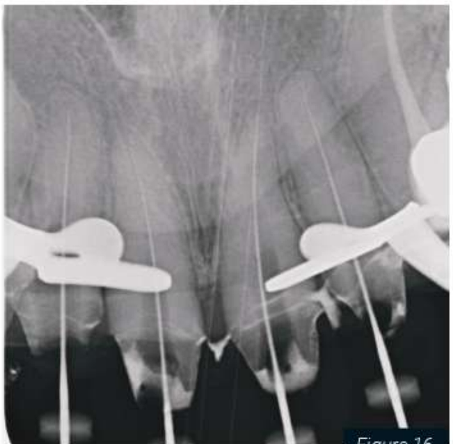

Figure 16

Figure 17

Figure 18

Post-operative recommendations are given to the patient, as well as a prescription for mouthwash, analgesic and anti-inflammatory.

Conclusion

In our case, the DNS made it possible to obtain permeability on the 4 teeth by optimizing tissue preservation and allowing reproducibility in the access technique.

The contribution of DNS to endodontics opens up possibilities for surgical root canal treatment, retreatments, ex-nihilo creation of a canal in a completely obliterated tooth, targeting of an MB2 canal on a maxillary molar.

This technique offers the practitioner the opportunity to be minimally invasive in complicated root canallsituations, in order to increase the chances of preservation of the tooth on the arch.

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