



## 3D Endo: Novel and Exciting Software for Endodontics

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### ABSTRACT

Cone-beam computed tomography has promoted changes in approaches in Endodontics, and enhanced decision-making in complex clinical cases. Even though the use of CBCT among endodontists has become more popular in the last decade, the potential of 3D imaging in clinical endodontic practice is hampered by limitations such as the low resolution of many CBCT machines and lack of analytical tools and lack adequate filters of CBCT software, to overcome some challenges of the CBCT technology such as artefacts. A new CBCT software package (3D endo software) to overcome these aspects and support diagnosing, determination of working length, planning and managing of endodontic cases. 3D Endo software has been developed to allow a more interactive and user friendly interface for the identification and visualization of root canals. This software can automatically identify the canal trajectory, measure root canal length, and also uses a color code for easier visualization of anatomic details such as early detection of confluences and curvatures in three-dimensions. It is used to crop the area corresponding to the tooth in the axial and para sagittal plane. This software features the option of creating a video that shows the virtual insertion of an instrument into the canals: can help clinicians observe pre-operatively the file trajectory to provide a subjective interpretation of canal complexities while the tooth is rotating through 360 degrees. As a result, the endodontic treatment is more efficient and significantly improves patient communication. This poster will review the detail in 3D Endo software.

**Keywords:** 3D Endo software, CBCT, Color coding, Working length determination

### INTRODUCTION

Decay, infection and trauma of tooth can all lead to a damaged dental pulp. With research it was found that tooth can survive without pulp. The rationale of root canal treatment is to remove the dental pulp and to clean the root canal of the tooth where the infection lies. Success of root canal treatment is influenced by the adequacy of working length during endodontic treatment. Proper assessment of root canal anatomy is vital for a successful endodontic procedure. 3D images like CBCT give better measurement and assessment of root canal anatomy and the determination of root canal length than 2D radiography like RVG.<sup>[1]</sup> To improve comprehension of tooth anatomy CBCT has become an established method for diagnosis of periapical pathologies, root fractures, internal external root resorptions. CBCT

imaging can display shape of the root canal and is able to show the apical foramen. CBCT is a validated tool used to explore root canal morphology in 3D planes. Axial slices can show root canal curvature angles and define the location of the major foramen.

In 1980s computed tomography was available for 3D dental imaging but due to high cost limited access and higher radiation exposure of 600  $\mu$ Sv, it was rarely used.<sup>[2]</sup>

In 1988, CBCT was introduced to dentistry. It produces clear images with higher resolution at a reduced radiation of 68  $\mu$ Sv and lower cost when compared to conventional CT.<sup>[2]</sup>

**ADVANTAGES OF CBCT:-**

CBCT has approximately 85% low radiation, much less than traditional CT scan. It is convenient and painless for patients. It is useful in the diagnostics, development of treatment plan and procedures. It also assesses risk before the treatment starts. It analyzes position and orientation of surrounding structures (sinuses, roots and nerves) better. It is cost effective and safe for patients of all ages

**DISADVANTAGES OF CBCT:-**

CBCT has some disadvantages like limited contrast resolution and emits radiation. Streaking and motion artefacts are possible in CBCT.<sup>[3]</sup> To overcome these disadvantages 3D Endo software has been introduced.

**3D ENDO SOFTWARE:**

Even though the use of CBCT among endodontists has become more popular in the last decade, the potential of 3D imaging in clinical endodontic practice is hampered by limitations such as the low resolution of many CBCT machines, lack of analytical tools and adequate filters of CBCT software. To overcome some challenges of the CBCT technology such as artefacts, a new CBCT software package (3D Endo software) has been introduced to support diagnosis, working length determination, treatment planning and management of endodontic cases.

3D Endo software has been developed to allow a more interactive and user friendly interface for the identification and visualization of root canals. This software can automatically identify the canal trajectory, measure root canal length, and also uses a color code for easier visualization of anatomic details such as early detection of confluences and curvatures in three-dimensions.<sup>[4]</sup> It is used to crop the area corresponding to the tooth in the axial and para sagittal plane. This software features the option of creating a video that shows the virtual insertion of an instrument into the canals: can help clinicians observe pre-operatively the file trajectory to provide a subjective interpretation of canal complexities while the tooth is rotating through 360 degrees. As a result, the endodontic treatment is more efficient and significantly improves patient communication. This review will reveal the detail in 3D Endo software.

Dentsply Sirona has introduced this new 3D imaging software to improve the planning and workflow of endodontic procedures. 3D Endo is the first CBCT-based software that enables endodontic treatments to be preplanned and optimized in combination with the imaging data from the ORTHOPHOS units.<sup>[5]</sup> Based on the 3D data and their specific visualization, the practitioner can case-specifically recognize the demands on the treatment of the root canal, analyse the natural shape of the root canal and select the appropriate files using the integrated file database. With the help of a planning report or directly in the software, the practitioner can clearly explain the initial situation and the appropriate treatment to the patient. This new software is a way in which the platform will redefine endodontic care for dental professionals and patients by setting new treatment standards in efficacy, safety and simplicity. Using this new software in combination with ORTHOPHOS units will provide practitioners the best image quality at the lowest dose of radiation and significantly improve their endodontic workflow.

**INDICATION FOR USE:-**

3D Endo Software is intended to aid in the visualization of anatomic form of root canal, periapical pathology, diagnosis and treatment planning of endodontic treatment.

**ADVANTAGES OF 3D ENDO SOFTWARE:**

3D Endo software is designed to improve treatment qualities. It helps to examine the tooth by making it isolated from other tooth. It gives a clear visualization of the tooth anatomy in 3D. It helps to identify all canals and anticipate risky areas. It also evaluates 3D working length and cavity access depth with locating canal orifices without opening the tooth. By the help of this software endodontist can plan for an optimal access cavity and final instrumentation. It investigates canal irregularities by following their curvature.

This software helps to simulate Intra-Root Camera View like visualizing throughout the canal.<sup>[6]</sup>

By using this software we have an intuitive way to analyse CBCT scan data because this software has simple and provides consistent methodology for all type of cases; useful on any PC with portable license key and easy to use.

**TECHNICAL SPECIFICATIONS: [6]****COMPUTER MINIMAL REQUIREMENTS**

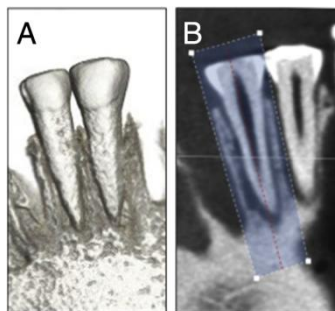
Operating systems	Windows 7, 8.1 or 10; 64 bit
Processor	3rd Generation Intel Core™ Processors or higher
RAM	4 GB or more
Free disk space	20 GB or more
Graphic card requirements	On-board Intel HD Graphics 2500 or higher
Screen resolution	1024 x 768 or better
Open GL requirements	Version 3.2 or higher
Measuring accuracy	<ul style="list-style-type: none"> <li>■ Length accuracy*: <math>\pm 0.5</math> mm</li> <li>■ Diameter accuracy*: <math>\pm 0.5</math> mm</li> <li>■ Angle accuracy*: <math>\pm 5^\circ</math></li> <li>■ Working length accuracy*: <math>\pm 0.5</math> mm (*For DICOM images with pixel size of 0.125 mm)</li> </ul>

**CBCT SPECIFICATIONS**

Minimum CBCT resolution	200 $\mu$ m
Input data type	CBCT standard DICOM
Other	Prescription form for CBCT scan request available in the software.
AAE and AAOMR Joint Position Statement May 2015	<a href="http://www.3dendo-na.com/aaestatement">www.3dendo-na.com/aaestatement</a>
ESE Position Statement January 2014	International Endodontic Journal, volume 47, issue 6, 502-504

**USES OF 3D ENDO SOFTWARE DURING ROOT CANAL TREATMENT:*****VISUALIZATION OF CANAL ANATOMY BY 3D ENDO SOFTWARE:***

3D Endo software (Dentsply Sirona, Salzburg, Austria) has been developed for specific treatment planning of endodontic procedures.<sup>[7]</sup> It presents an intuitive interface in which the clinician can follow steps for the identification and measurement of the canals as well as virtual planning of the access cavity, apical limit, and file selection for shaping procedures. This software enhances the 3-dimensional (3D) visualization of the canal complexities such as curvatures and confluences.<sup>[8]</sup> An innovative feature of this software is the semi automated detection of the root canal trajectory.



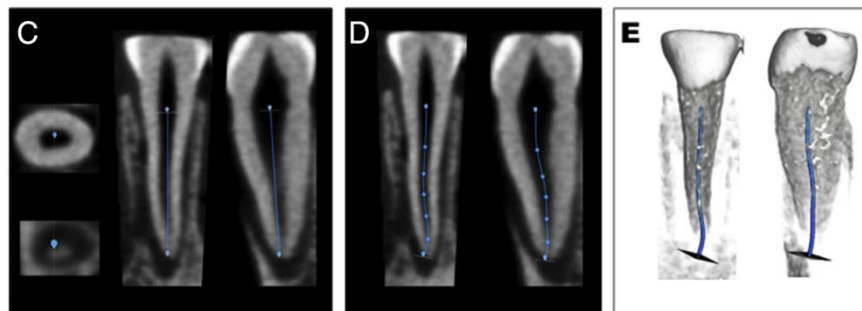
(A) Initial 3D rendering of the CBCT image and (B) the selection of the tooth using the crop tool

***ACCESS CAVITY DESIGNING AND CREATION:***

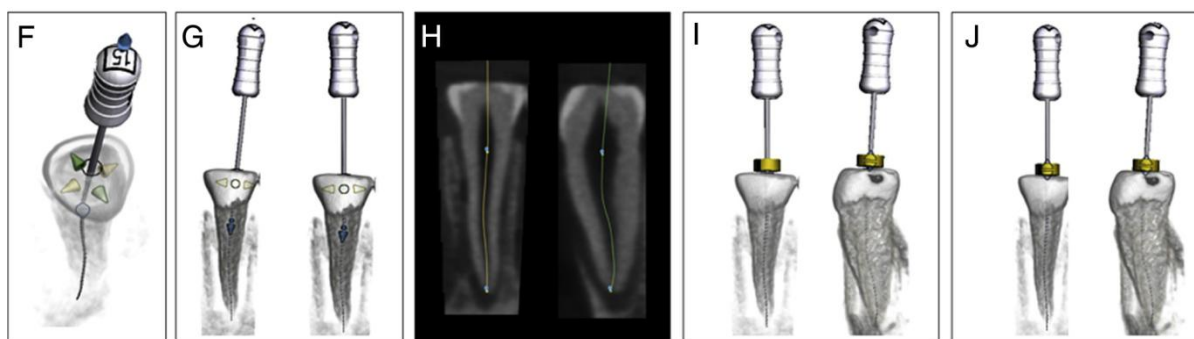
By this software access cavity designing and creation is possible. 3D-Endo software allows the operator to locate and design the endodontic access virtually, and then the length is measured by using a virtual file whose trajectory complies with the canal pathway and the determined access position. This feature is likely to increase the accuracy of the WL because in a real situation the location of the access potentially changes the angulation of the file and its relation to the coronal reference. This might be correlated with the higher percentage of acceptable measurements of 3D Endo.

***DETERMINATION OF WORKING LENGTH BY 3D ENDO SOFTWARE:***

3D Endo software is dedicated to endodontics that presents automated functions for preoperative working length determination. It is considered reliable and similar to conventional CBCT software, but measurements should be clinically confirmed using an apex locator.<sup>[9]</sup> After identifying the orifice and apical foramen, an automated line connecting them is generated, which can be adjusted to follow the canal trajectory in 3 dimensions. Using this trajectory as a reference, a virtual endodontic file can be used to estimate the working length, using either an automatic suggestion or manual adjustment by the clinician. This semi-automated detection of the canal trajectory has the potential to minimize subjective errors related to the operator's skills.







The sequence for obtaining the WL using 3D Endo software. (C) A blue pin is used to locate both (top) the orifice and (bottom) the apical foramen, which are then automatically connected by a line. (D) The trajectory was adjusted following the curvatures of the root canal in both the BL and MD views (D). (E) The 3D canal pathway can be visualized by changing the transparency of the rendered model. (F) The occlusal view showing the virtual 15 K-file inserted in the canal trajectory; the black circle indicates (G left) the virtual location for the access that can be repositioned by using the green and yellow arrows, resulting in (G right) the proper coronal angulation of the file. The blue arrows in F and G allow the apical positioning of the file, which was set at 0.0 mm from the foramen. (H) The final trajectory, from the centre of the access to the foramen. The BL and MD views for (I) suggested length (3D-SL) and (J) operator-adjusted length (3D-OL).<sup>[7]</sup>

#### **EVALUATION OF BIO-MECHANICAL PREPARATION OF ROOT CANAL BY 3D ENDO SOFTWARE:**

This software obviously compares the pre and post treatment canal and automatically calculates the quantity of dentin removed for each new section and estimates the percentage of untouched surface. The percentage of untouched canal surface is very important to characterise the goodness of the root canal preparation and it should be lower as possible for a good endodontic treatment.<sup>[10]</sup> The software helps the user to recognize untouched surface zone and using the pattern of the canal axe. The user will be able to calculate any desired correlation i.e. correlate the curvature radius and local percentage of untouched surface or correlate the presence of critical zones such as curves, constrictions, bifurcations with the quantity of dentin removed.

#### **DETERMINATION OF OBTURATION BY 3D ENDO SOFTWARE:**

In post obturation 3D Endo software helps in inspection of adaptation of obturating material to canal wall which is very important for success of endodontic treatment. Untouched zone can be easily recognized.<sup>[10]</sup>

#### **CONTRAINDICATIONS:**

3D Endo software should not be used for implants or any other dental procedure outside endodontics.<sup>[6]</sup>

#### **WARNINGS:-**

There are no known serious adverse reactions or potential safety hazards for using 3D Endo software.

#### **PRECAUTIONS:-**

The application will automatically install the latest version. The computer should be regularly connected to the internet when running the 3D Endo Software. The quality of the images in the 3D Endo software depends on the quality of the original CBCT scans. To obtain optimal results, clinician should use the scan parameters specified in the CBCT scan prescription form.<sup>[10]</sup> This product should be used by trained clinicians with experienced reading and understanding CBCT scan data. The file position and bending is defined from the canal midline identified by the user without any clinical interpretation of the specific tooth anatomy.

#### **CONCLUSION:**

The 3D Endo software helps to visualize the complex anatomy of root canal before the endodontic treatment is started. The correction of the access cavity can be planned to enable a straight line access and allow a complete chemo-mechanical disinfection. The possibility of 3D pre-endodontic treatment planning is a significant gain for modern endodontics and can help to prevent procedural errors, especially in complex cases. Nonetheless root canal lengths that are measured with the software should always be

verified using an apex locator, as several parameters such as the extent of the access cavity, amount of coronal preflaring, the straightening of the canal and the choice of reference point can have an influence on measurements.

## REFERENCES

1. Muhammad Khan Asif , Phrabhakaran Nambiar, Iqra Muhammad Khan, Zeti Adura Binti Che Ab Aziz et al.; Enhancing the three-dimensional visualization of a foreign object using Mimics software; Elsevier: RCR 14 (2019);1545-1549.
2. Mihaela-Jana Țuculina, Larisa Veronica Cojocaru, Diana Silvia Duțu, Raluca Ioana Ghilaciu; The use of radiology and CBCT in dentistry; Journal of Dental and Medical Sciences (2018); Volume 17; Issue 3; Ver.6; 78-81.
3. Cone Beam-Computed Tomography in Endodontics; Endodontics: Colleagues for Excellence; Summer 2011; American Association of Endodontists.
4. G Gambarini, P Ropini, L Piasecki, R Costantini et al.; A preliminary assessment of a new dedicated endodontic software for use with CBCT images to evaluate the canal complexity of mandibular molars; Int Endod J; 2017; 51: 259-268.
5. Endo Meets 3D: Dentsply Sirona has developed new 3D Endo Software for Better, Safer and Faster Endodontics; Press Release (Aug 8, 2016); Dentsply Sirona.
6. 3D Endo Software Brochure; Dentsply Sirona.
7. Di Nardo D, Gambarini G, Costantini R, Testarelli L, Piasecki L, Al-Sudani D; 3D clinical evaluation of unusual anatomy of a maxillary second molar: a case report; Biomed J Sci & Tech Res; 2018; 2: 1-4.
8. Andre Vinicius Kaled Segato, Lucila Piasecki, Marcos Felipe Iparraguirre Nunovero, Ulisses Xavier da Silva Neto, et al.; The Accuracy of a New Cone-beam Computed Tomographic Software in the Preoperative Working Length Determination: Ex Vivo; J Endod 2018; 44: 1024–1029.
9. Raffaele Sinibaldi, Raffaella Pecci, Francesco Somma, Stefania Della Penna, et al.; A new software for dimensional measurements in 3D endodontic root canal instrumentation; Ann Ist super sAnItà 2012; Vol. 48; no.1: 42-48.
10. 3D Endo Software User Manual; Dentsply Sirona.