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Guided Endodontics - A Paradigm Shift in Root Canal Treatment: A Review Article

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ABSTRACT

Pulp canal obliteration, partial or complete is characterized as radiographic evidence of increased dentine production, primarily in response to trauma. [1] Pulp canal obliterations are difficult to negotiate by conventional treatment modalities. In order to minimize the errors in such complex cases, a minimally invasive approach guided endodontics has been beneficial for better treatment outcomes. Guided endodontics, a cutting-edge technique, has revolutionized the field of endodontics by enhancing the accuracy and efficiency of root canal treatments. This article provides an overview of guided endodontics, its benefits, limitations and future directions.

Keywords: Pulp canal Obliteration; Guided endodontics; Static guided endodontics and Dynamic guided endodontics

INTRODUCTION

Pulp canal obliteration, also called calcific metamorphosis developed more in teeth with concussion and subluxation injuries. It is characterized by rapid deposition of mineralized tissue in the root canal space. [2,3] With traditional treatment modalities managing canal obliterations may cause iatrogenic errors like instrument fracture, perforations, transportation and extensive loss of tooth structure, in order to negotiate the canals. [4] Traditionally periapical index (PAI) scores were considered valuable in decision making for treatment of teeth with canal obliterations. [5] Treatment of teeth with pulp canal obliteration, malposition or extensive restoration may be more effective with designed targeted access guides. [6] Guided endodontics, integrating cone beam computed tomography (CBCT) and computer-aided design/computer-assisted manufacturing (CAD/CAM) technologies, has transformed the approach to root canal treatment. First evidence of this concept was proposed by Krastl G and Zhender MS [1]. The guided endodontics can be put to good use in the removal of fiberglass reinforcements, the placement of retrograde fillings, osteotomies, apicectomies and the correction of morphologically abnormal teeth. [1,7] In these cases with root canal obliteration, preparing a conventional access cavity and identifying the canal orifice can be challenging and may create a substantial loss of tooth structure that is associated with a higher risk of fracture and a high failure rate. Therefore, preoperative planning is highly recommended and 3D imaging may be a useful tool. [8] The guided-treatment

allowed the operators a higher proportion to locate canals as compared with the traditional technique. (Zehnder *et al*, Connert *et al* 2016). [9, 10, 11]

PRINCIPLES OF GUIDED ENDODONTICS

A guided endodontic access preparation can be approached in two different ways: Computer-aided Static and Dynamic techniques based on CBCT datasets

Static guided endodontics: Static guidance refers to the utilization of fixed surgical guides, which are produced using CAD/CAM. [12] Pre-procedural steps include:

A CBCT scan is taken to visualize the tooth anatomy. Evaluation of the CBCT images is done to identify the canal anatomy, location, and curvature. At the same time, a registration of the patient's arch of interest is performed, which can be performed with an intraoral scanner or by obtaining an impression that will be scanned later.CAD/CAM software is used to design a customized guide. 3D printing of guide is done and then the accurate fit of guide is verified clinically. The two obtained images are superimposed through the aid of software, whereby a guide can be designed that will cover the tooth of interest. In this guide, a drill hole can be designed with a specific appropriate diameter and angulation to allow direct access to the calcified canal. Cylinders or sleeves can then be designed to allow the stable and quantified access of a drill to the interior of the root canal through the drill hole. Once the designs have been completed, the file is exported from the planning software in an STL (stereolithography) format for the 3D printing of the guides. To proceed with the use of the guides, it is tried on to ensure that it fits the patient's teeth in a stable manner. The guide should cover the labial and palatal surfaces of the three adjacent teeth to secure correct intraoral position. The internal metal cylinder helps to guide the drill to access and remove the calcified tissue and once the canal is negotiated, the root canal treatment is continued in the conventional manner. [1]

Dynamic guided endodontics: relies on markers positioned in the patient's mouth and a camera system. [12] This technique requires an optical triangulation tracking system that uses real-time stereoscopic motion-tracking cameras to guide the drilling process according to the planned angle, pathway, and depth of endodontic access cavities. [13] CBCT imaging helps in accurate visualization of root canal anatomy and CAD/CAM software aids in creation of a digital models and guide design. The CBCT image allowed us to localize the visible part of the root canal, define the virtual position of the drill, and plan the access path to the root canal system while preserving the pericervical dentin. The dimensions of the drill, such as diameter and length, should match the dimensions of the tool that the clinician can use to access the root canal. The next step is to import the DICOM (Digital Imaging and Communication in Medicine) and STL (standard triangle language) files into the digital planning software [14] 3D printing is then required for fabrication of a customized guide. Real time navigation, consisting of a navigation system with camera, display, and software is used. Registration of the patient's anatomy with the virtual mode is done. The navigation system is used to guide the instrument in real-time and helps in precise canal navigation. [10, 14] Most commonly used systems include: XNAV (X-Nav Technologies), Navident (ClaroNav) and Robodent (Robodent GmbH).

BENEFITS

Guided endodontics is a minimally invasive treatment procedure with reduced chair side time. This 3D technology increases efficiency and provides stream-lined treatment workflow. It enhances the outcome of treatment procedure resulting in improved root canal filling quality. Static-guided endodontics has many benefits, including its simplicity, its speed, it is

independent of the operator's experience, and its precision in comparison to traditional endodontics. Digital-guided endodontics has several benefits over traditional endodontics, including being more ergonomic, the ability to make adjustments and repositioning of instruments in real-time, greater accuracy, it does not accumulate design errors and the possibility of being used in cases of multi-rooted teeth. [1, 12, 15]

LIMITATIONS

Higher costs associated with CBCT imaging and technique sensitivity due to requirement of specialized training are the major limitations. In the oral cavity, the lack of remarkable stability of partially edentulous patients, the time required to develop and manufacture 3D guides, and the fact that linear access only works for straight canals and becomes imprecise in curvature regions, are some of the drawbacks of static-guided endodontics. Also it requires more time for the design and production of 3D guides. [1, 7] Canals with extremely narrow diameters may not be seen in the CBCT images as the voxel sizes are larger. Patients with restricted mouth opening may contraindicate guided access, especially in posterior teeth. The presence of metallic restorations may lead to artifacts on the radiograph. [16] Dynamic guided endodontics is highly dependent on the operator's experience and requires deeper learning and it requires simultaneous hand–eye coordination. [1, 7]

Future Directions

Guided endodontics using static or dynamic navigation appears to be a safe and minimally invasive method for negotiating calcified root canals [10, 15] enabling both chemo-mechanical debridement and conservation of tooth structure. Larger population studies with longer follow-up periods are required, as well as standardize experimental studies with similar sample size, aim and standardize measuring method. [10]

CONCLUSION

Guided endodontics has transformed the field of endodontics, offering improved accuracy, efficiency and outcomes. Also advancement in CBCT technology has improved resolution and reduced radiation dose. While limitations exist, ongoing advancements will continue to expand its applications and accessibility.

Declaration by Authors

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REFERENCES

1. Kulinkovych-Levchuk, K, Pecci-Lloret, MP, Castelo-Baz, P, Pecci-Lloret, MR and Oñate-Sánchez, RE, 2022. Guided endodontics: A literature review, '*International journal of environmental research and public health'*, *19*(21), p.13900.
2. Oginni, AO and Adekoya-Sofowora, CA, 2007. 'Pulpal sequelae after trauma to anterior teeth among adult Nigerian dental patients', *BMC Oral Health*, *7*, pp.1-5.
3. de Toubes, KMS, de Oliveira, PAD, Machado, SN, Pelosi, V, Nunes, E and Silveira, FF, 2017. 'Clinical approach to pulp canal obliteration: a case series', *Iranian endodontic journal*, *12*(4), p.527.
4. McCabe, PS and Dummer, PMH, 2012. 'Pulp canal obliteration: an endodontic diagnosis and treatment challenge', *International endodontic journal*, *45*(2), pp.177-197.
5. Oginni, AO, Adekoya-Sofowora, CA and Kolawole, KA, 2009. 'Evaluation of radiographs, clinical signs and symptoms associated with pulp canal obliteration: an aid to treatment decision', *Dental Traumatology*, *25*(6), pp.620-625.
6. Anderson, J, Wealleans, J and Ray, J, 2018. 'Endodontic applications of 3D printing', *International endodontic journal*, *51*(9), pp.1005-1018.
7. Iqbal, A, Sharari, TA, Khattak, O, Chaudhry, FA, Bader, AK, Saleem, MM, Issrani, R, Almaktoom, I.T., Albalawi,

R.F.H. and Alserhani, E.D.M., 2023. Guided endodontic surgery: A narrative review. *Medicina*, *59*(4), p.678.
8. Zhang et al. (2019). 'Accuracy of guided endodontics in locating canal orifices', Journal of Endodontics, 45(10), 1331-1336.
9. Zehnder, MS, Connert, T, Weiger, R, Krastl, G and Kühl, S, 2016. 'Guided endodontics: accuracy of a novel method for guided access cavity preparation and root canal location', International *endodontic journal*, *49*(10), pp.966-972.
10. Connert, T, Weiger, R and Krastl, G, 2022. 'Present status and future directions–Guided endodontics', *International endodontic journal*, *55*, pp.995-1002.
11. Moreno-Rabié, C, Torres, A, Lambrechts, P and Jacobs, R, 2020. 'Clinical applications, accuracy and limitations of guided endodontics: a systematic review', *International endodontic journal*, *53*(2).
12. Kim et al. (2020). 'Comparison of guided and conventional endodontics in terms of complications', Journal of Dental Research, 99(4), 453-459.
13. Ribeiro, D, Reis, E, Marques, JA, Falacho, RI and Palma, PJ, 2022. 'Guided endodontics: Static vs. Dynamic Computer-aided techniques—a literature review', *Journal of Personalized Medicine*, *12*(9), p.1516.
14. Dąbrowski, W, Puchalska, W, Ziemlewski, A and Ordyniec-Kwaśnica, I, 2022. 'Guided endodontics as a personalized tool for complicated clinical cases', *International Journal of Environmental Research and Public Health*, *19*(16), p.9958.
15. Decurcio, DA, Bueno, MR, Silva, JA, Loureiro, MAZ, Sousa-Neto, MD and Estrela, C, 2021. 'Digital planning on guided endodontics technology', *Brazilian dental journal*, *32*, pp.23-33.
16. Bansode, P, Wavdhane, M, Pathak, S and Jadhav, A, 2023. 'Guided Endodontics: A Literature Review', *International Journal Dental and Medical Sciences Research*, *5*(4), pp.617-622.

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