MAGIC WAND IN THE HANDS OF ENDODONTISTS: GUIDED ENDODONTICS

Abstract

Guided endodontics is a cutting-edge technology that revolutionizes the precision and accuracy of root canal procedures. The importance and benefits of using guided endodontics in practice are examined in this chapter. In contrast to conventional techniques, guided endodontics combines accurate instrument tracking, computer-assisted technology, and real-time imaging to improve procedural results. Cone-beam computed tomography (CBCT) is employed to provide three-dimensional imagery. This allows for accurate navigation through intricate root canal systems and a detailed view of the anatomy of the tooth. Continuous feedback is provided via guided endodontics, which enables endodontists to track the process in real time and guarantee ideal irrigation and instrumentation. This technology improves total treatment efficiency, lowers radiation exposure for practitioners and patients, and lessens the possibility of operational errors. Because guided endodontics is interactive, it facilitates educated decision-making and individualized treatment plans, which supports a more patient-centric approach. Because of this, endodontists are able to navigate complex canal architecture with remarkable accuracy, which eventually improves endodontic therapies' success rates and long-term results. The adoption of guided endodontics into endodontic practice is a revolutionary step that gives a viable path toward improving the accuracy and effectiveness of root canal therapy.

Keywords: Endodontics, Navigation System, Magic wand

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I. INTRODUCTION

Endodontics, the branch of dentistry dedicated to the study and treatment of dental pulp and periapical tissues, plays a crucial role in preserving natural teeth. It is important to gain a comprehensive understanding of guided endodontics, a technique that combines advanced technology and clinical expertise to achieve predictable and successful outcomes in root canal treatment.

II. GUIDED ENDODONTICS

With the evolution in the era of advancements of instrument and technology the approach from G V Black's "extension for prevention" has shifted to "prevention of extension" With this aid comes the advancement in many treatment modalities such as anatomical determination of the tooth, improvised ways to make access in tooth, surgical treatment.

Guided endodontics encompasses the integration of advanced technology and clinical expertise to achieve predictable and successful outcomes in root canal treatment. The primary purpose is to enhance treatment predictability, improve procedural efficiency, and optimize clinical outcomes. By using 3D imaging, CAD, and CAM technologies, guided endodontics provides detailed visualization, aiding in the identification of complex anatomical variations and facilitating accurate treatment planning.[(1)]

According to Buchanan (2018) Dr. Charles Maupin was the 1st dentist to use dynamic navigation system in 2016.

Guided endodontics is a novel approach used in management of obliterated root canals, periradicular surgery and auto transplantation. [(2)]

Guided Endodontics divided into 2 parts:

1. Static Navigation System
2. Dynamic Navigation System

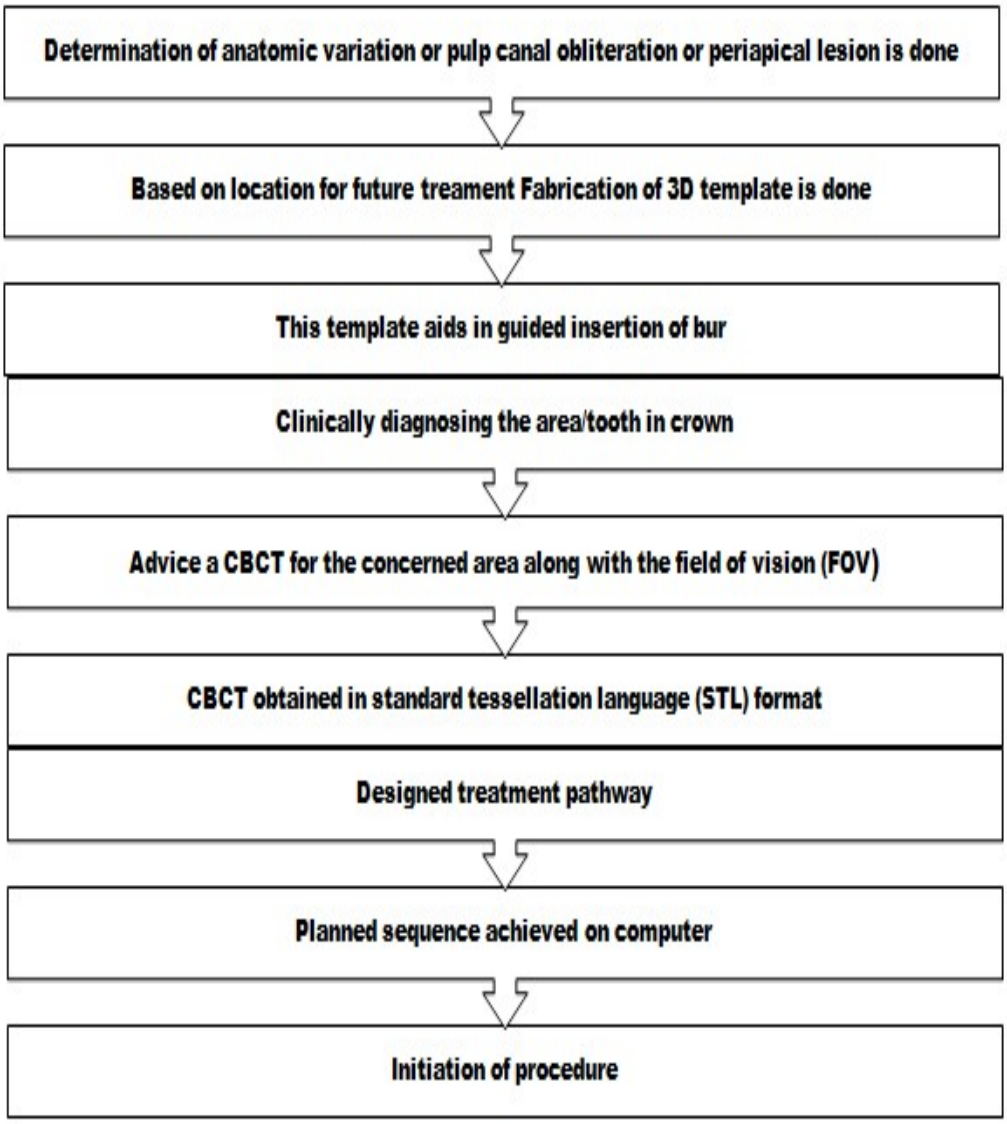
III. STATIC NAVIGATION SYSTEM

The static navigation aids in detection and helps in treating the tooth without any real-time feedback. It is based on predetermined investigation and path of insertion. A template (3D) is made prior to initiation of treatment based on the obtained Cone beam computed tomography (CBCT) and following with the steps are taken.[(3)]

1. Steps for Static Navigation System

- **Used in**: [(4-8)]
  - Endodontic access and accurate detection of root canal
  - Less freehand preparation using Dynamic navigation system (DNS).
  - Less time consuming
  - Management of pulp canal obliteration
  - Less 2D deviation

- Endodontic retreatment easy access with few deviation and gauging or no perforation
- Endodontic microsurgery
- Less angulation deflection
  Eg: Navident, X guide, ImplNav, Denacam



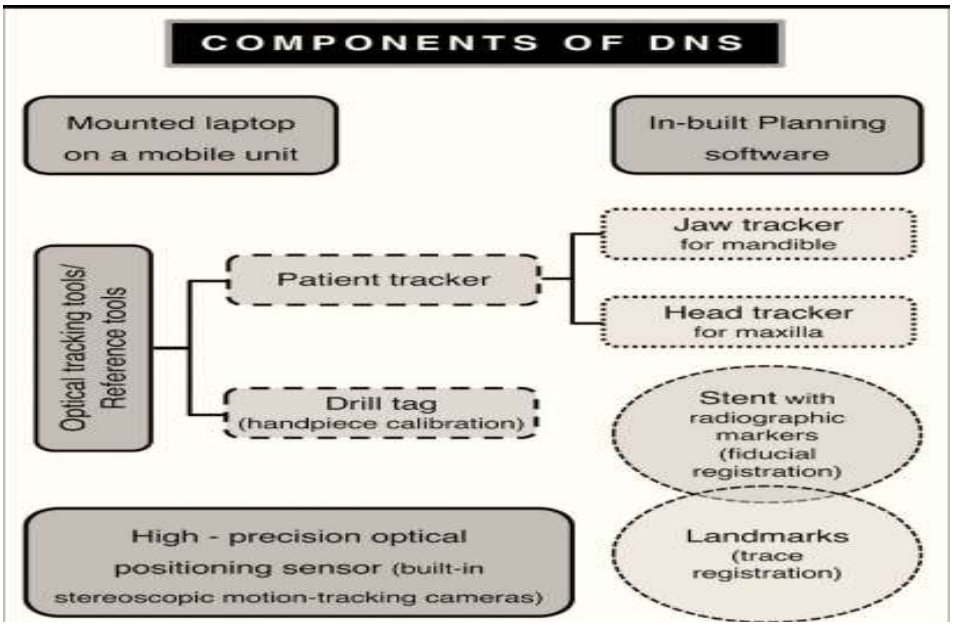


Figure 1

IV. DYNAMIC NAVIGATION SYSTEM (DNS)

A dynamic navigation is a novel minimally invasive is a novel minimally invasive treatment for treating pulp canal obliteration, aids in surgical treatment such as osteotomy, apicectomy etc. this system is superior as it provides real-time feedback and guidance to the clinician during access cavity preparation and canal instrumentation. The hand-piece movements are tracked, and the software displays the exact location of the instruments on the digital model, ensuring precise alignment and angulation. [9]

Components:

- Computer
- CBCT
- Template
- Head and Mouth Stabilizer
- Tracer tracking tool
- Calibration Device

1. Steps of Dynamic Navigation System

- **Preoperative Phase:** The preoperative phase of guided endodontics involves careful case selection and obtaining high-resolution cone beam computed tomography (CBCT) scans.

  Selecting appropriate cases for guided endodontics is critical, considering factors such as complex anatomy, previous treatment history, and accessibility.

CBCT imaging provides detailed 3D images of the tooth and surrounding structures, aiding in treatment planning, identifying anatomical variations, and locating potential challenges.

2. **Steps Includes**
   - Clinically diagnosing the area/tooth in crown
   - Advice a CBCT for the concerned area along with the field of vision (FOV)
   - CBCT obtained in standard tessellation language (STL) format
   - Determination of anatomic variation or pulp canal obliteration or periapical lesion is done
   - Based on location for future treatment Fabrication of 3D template is done
   - The static surgical guide is positioned accurately over the tooth, guiding access cavity preparation and canal instrumentation.
   - Sterilize using ethanol prior to use
   - Designed treatment pathway
   - Planned sequence achieved on computer
   - Place the mouth and head stabilizer
   - Activate the tracer tracking tool
   - With the use of calibration device calibrate the instrument to be used
   - As it gives a real time feedback calibration of instruments is an important step in the procedure
   - Predetermined path of insertion reflects on screen visible to clinician
   - The calibrated instrument is verified for calibration
   - Predetermined path reflected in white, current movement of instrument reflected in green and any deviation reflected in red
   - If patient moves, the real-time feedback moves along with the patient, hence no recalibration required
   - Procedure continued

3. **Indications**
   - Pulp canal obliteration
   - Osteotomy
   - Canal preparation
   - Access opening persisting dental anomalies
   - Retreatment of root canal
   - Apicectomy

4. **Contraindications**
   - Poor patient compliance
   - Patient with TMJ disorder
   - Patient with fracture of maxilla and mandible

5. **Postoperative Phase:** In the postoperative phase of guided endodontics, thorough irrigation and disinfection of the root canal system are performed following canal instrumentation.

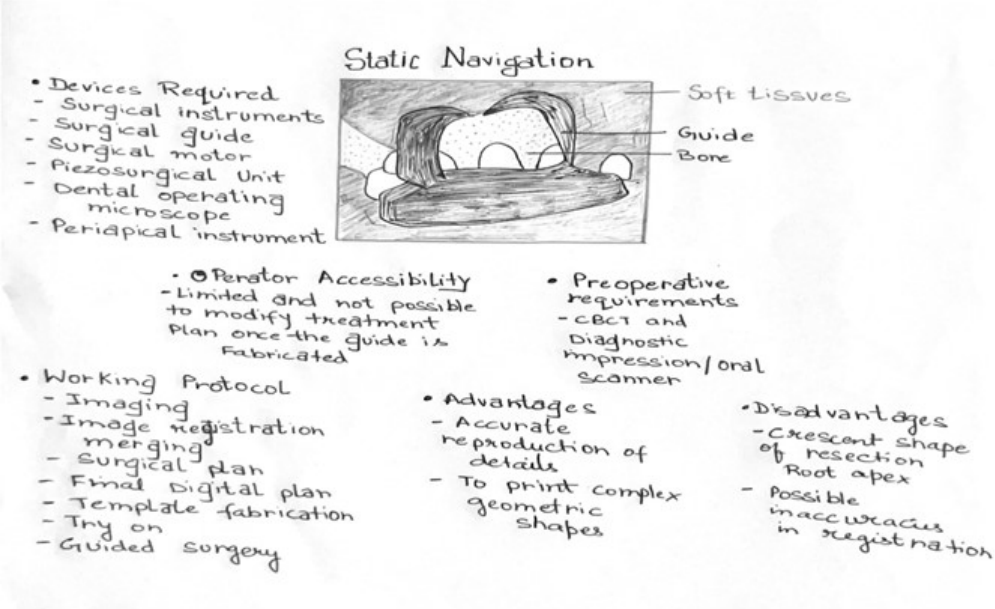


Figure 2

Obturation techniques, such as traditional methods or contemporary approaches like warm vertical compaction or single-cone obturation, are employed to achieve a three-dimensional seal.

Postoperative evaluation, through radiographs or CBCT scans, is conducted to assess the quality and accuracy of the treatment.

This evaluation helps identify any potential complications or missed canals that may require further attention or intervention.

6. Workflow and Setup for Dynamic Navigation System (10)

Static Navigation System Advantages	Dynamic Navigation System Advantages
Novel minimally Invasive treatment with Enhanced Patient Communication and Education.	Novel minimally Invasive treatment with Enhanced Patient Communication and Education
Allows predetermination of treatment therefore providing less chances of iatrogenic errors.	Allows predetermination of treatment with real-time feedback therefore providing less chances of iatrogenic errors and improved efficiency
Clear image of underlying anomalies and anatomical changes which might be unclear on 2D radiograph	Clear image of underlying anomalies and anatomical changes which might be unclear on 2D radiograph
Head and mouth of patient stabilized	Head and mouth stabilized with inbuilt tracer tracking tool

Static Navigation System Disadvantages	Dynamic Navigation System Disadvantages
Expensive set-up	Expensive set-up
Learning curve but takes time; Beginner level friendly	Learning curve but takes time; Hand eye coordination requires time
With patient movement, calibration and predetermined path is lost, thus recalibration of these devices needs to be done	With patient movement, calibration and predetermined path is not lost, therefore no need for recalibration
No real-time feedback provided	Real-time feedback is provided but cannot be grasped by beginner.

V. GUIDODONTICS IN MODERN ENDODONTIC PRACTICE [11]

A novel treatment modality has cone in advancement following the steps of this guided endodontics with the dawn of era termed as GUIDODONTICS.

Guidodontics refers to the integration of guided endodontics with digital dentistry in the field of endodontics. It involves the utilization of advanced technologies, including CBCT imaging, CAD/CAM software, 3D printing, dynamic navigation systems, and global positioning system. (GPS) to enhance treatment planning, execution, and outcome predictability.

1. Indication

- Pulp canal obliteration
- Osteotomy
- Canal preparation
- Access opening persisting dental anomalies
- Retreatment of root canal
- Apicectomy
- Location of missed canals

2. Contraindication

- Mobile tooth
- Fracture of jaw
- Poor patient compliance
- Underlying condition such as lock jaw

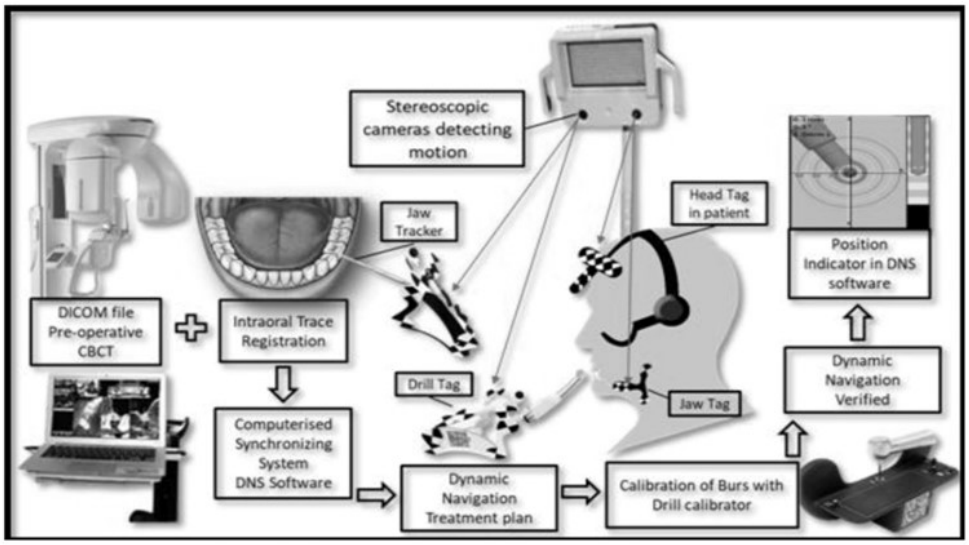


Figure 3

3. **Advantages:** The incorporation of Guidodontics in modern endodontic practice offers various advantages:

   - **Precise Treatment Planning**: Guidodontics enables clinicians to precisely plan the root canal path, taking into account intricate anatomical variations and complexities. This precision enhances treatment predictability and improves clinical outcomes.

   - **Streamlined Workflow**: The integration of digital technologies within Guidodontics optimizes the treatment process, reducing chairside time and increasing efficiency.

   - **Enhanced Communication:** Guidodontics facilitates effective communication with patients through the use of 3D visual aids, allowing for better patient comprehension, informed consent, and shared decision-making.

   - **Superior Clinical Outcomes**: The precision and control offered by Guidodontics contribute to improved clinical outcomes, including successful root canal treatment and long-term preservation of natural dentition.

4. **Steps during Guidodontics Device**
   - Clinically diagnosing the area/tooth in crown
   - Advice a CBCT for the concerned area along with the field of vision (FOV)
   - CBCT obtained in STL format
   - Determination of anatomic variation or pulp canal obliteration or periapical lesion is done
   - Based on location for future treatment Fabrication of 3D template is done
   - This template aids in guided insertion of bur
   - Autoclave the template and sterilize using ethanol prior to use
   - Verify the fit and orientation in patient's mouth
   - Administer local anesthesia
   - Designed treatment pathway

- Planned sequence achieved on computer
- Place the mouth and head stabilizer
- Activate the tracer tracking tool
- With the use of calibration device calibrate the instrument to be used
- As it gives a real-time feedback calibration of instruments is an important step in the procedure
- Predetermined path of insertion reflects on screen visible to clinician
- The calibrated instrument is verified for calibration
- Predetermined path reflected in white, current movement of instrument reflected in green and any deviation reflected in red
- If patient moves, the real-time feedback moves along with the patient, hence no recalibration required
- For example if treatment carried out is of osteotomy, Lindamann bur is used having 3-4mm width sufficient for insertion of micro-surgical instrument and ultrasonic instrument
- Procedure continued
- The GPS installed calibrated tracer tool gives the positioning of instrument

VI. CONCLUSION

Guided endodontics, incorporating static and dynamic navigation systems, along with the concept of Guidodontics, has revolutionized modern endodontic practice. These advanced technologies offer heightened precision, efficiency, and clinical outcomes. As dental students, acquiring knowledge and practical experience in guided endodontics and Guidodontics will equip you with the skills necessary for contemporary endodontic treatment. By comprehending the principles, advantages, and step-by-step procedure of guided endodontics, including static and dynamic navigation systems, and recognizing the concept of Guidodontics, you will be well-prepared to integrate these techniques into your future clinical practice and provide optimal care to your patients. The integration of technology and clinical expertise in guided endodontics paves the way for a more predictable and successful endodontic treatment approach, ensuring the preservation of natural dentition and promoting overall oral health.

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