Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 23s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Comparative Study Between Dynamic Navigation System And Guided Endodontics In Access Cavity Preparation

Ihab El Sayed Hassanein[***], *Shady Ali Hussien[**]*, *Mahmoud Lotfy El Gharib[*]*

[***]Professor of endodontics, Faculty of Dentistry, Ain Shams University

[**]Professor of endodontics, Faculty of Dentistry, Ain Shams University

[*]Faculty of Dentistry, Ain Shams University.

.Cite this paper as: Ihab El Sayed Hassanein, Shady Ali Hussien, Mahmoud Lotfy El Gharib, (2025) Comparative Study Between Dynamic Navigation System And Guided Endodontics In Access Cavity Preparation. *Journal of Neonatal Surgery*, 14 (23s), 999-1007.

ABSTRACT

Aim :. The aim of the present study was to compare between two computer guided access cavity designs: Dynamic Navigation Access and Guided Access with Traditional Access Cavity in respect to the Procedure time, Percentage of hard tissue removal.

Methods: forty-five 3D printed maxillary first permanent molar were divided into three groups: **Group I** (Dynamic navigation guided access), **Group II (**static guided access**) Group III (**conventional access**)**. CBCT scans taken for all mounted treatment teeth. Pulp chamber volume is calculated using 3D Slicer. Access cavity was done in each group according to the system used. The time taken during access was recorded in seconds. Afterwards, CBCT scans taken and Pulp chamber volume is calculated using 3D Slicer to assess the amount of dentin lost.

Results: There was a significant difference between different groups in access time ,the highest mean time was found in group (III) , followed by group (I) while the lowest time was found in group (II). Regarding percentage of dentin lost there was a significant difference between different groups highest mean lost dentine was found in group (III) followed by group (I) while the lowest value was found in group (II).

Conclusion: Static guided access is a time saver with conservative approach.

Keywords: *guided access, navident , static guide , dentin lost*

1. INTRODUCTION

Although traditional access preparations have consistently achieved the required goals, concerns were raised on their effect on tooth survivability and resistance to fracture. Conservative access cavity aims to conserve as much tooth structure as possible and preserve a significant amount of the pulp chamber roof and the pericervical dentin.[1]

Computer-assisted access cavity (CAAC) preparations, as the name suggests, include the use of software and 3-dimensional imaging to assist in establishing a predictable path to the root canal space while conserving the tooth structure. This approach was imported from implant dentistry, and it is considered a form of minimally invasive access. It can be classified into two types. The first is the ***Guided Access Cavity (GAC)***, the other computer-assisted design is referred to as ***Dynamic-Navigated Access.***

The Dynamic Navigation system (DNS) is a breakthrough technology for minimally invasive procedures. It applies a highly desired guided endodontic concept to surgical and non surgical procedures. DNS in endodontics first appeared in the literature in 2019, focusing on creating conservative access cavities and locating canals, which demonstrated its potential use in guided endodontics. Since then, the DNS's potential has been explored for different applications in endodontics. Currently, the DNS has been considered for conventional and minimally invasive access cavities, locating calcified canals, endodontic microsurgery, post removal, and intraosseous anesthesia anesthesia.[2, 3, 4]

The DNS workflow is simple and straight forward. The ideal drill position is virtually planned by the surgeon in the preoperative cone-beam computed tomography (CBCT) dataset uploaded to the planning program. Sensors attached to the handpiece and the patient's teeth transfer the 3D spatial information to a stereo tracker (fig.5). [5 6] This technology has motion-tracking optical cameras and CBCT images of the position of the virtually planned surgery that provide 3Dreal-time dynamic navigation with visual feedback to intra- operatively guide surgical instruments. Most importantly, the surgeon can adjust the treatment course in real time.

The traditional workflow of static guided endodontics is based on the principle of template guided implantology. Uses intraoral scanners and CBCT imaging to create a custom-made stent with attached sleeves that guides the access drill to the desired location. This type of cavity is conservative, purpose based, and not operator dependent. A few limitations of the GAC include longer treatment planning and delayed treatment, poor accessibility in posterior teeth especially in limited mouth opening, and overheating while drilling.

The aim of the current study was to evaluate the Procedure time, Percentage of hard tissue removal, of two computer guided access cavity designs: Dynamic Navigation Access and Guided Access with Traditional Access Cavity

MATERIALS AND METHODS

1. Aim:

The aim of the present study was to compare between two computer guided access cavity designs: Dynamic Navigation Access and Guided Access with Traditional Access Cavity in respect to the Procedure time, Percentage of hard tissue removal.

2. Study design:

The present study was an in vitro study. This study was approved by the Ethics Committee of Faculty of Dentistry Ain Shams University (Research ethics approval code: FDASU-Rec PC 052314).

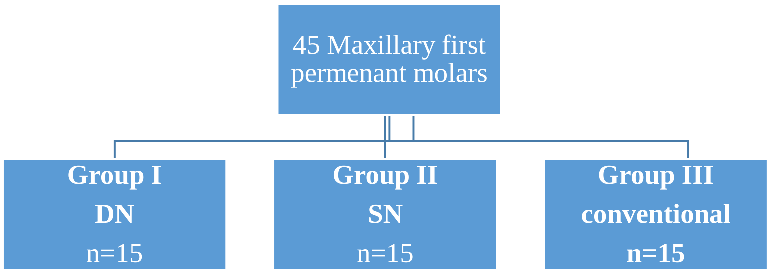


Figure (1): Sample grouping

3. Study settings:

- Private maxillofacial radiology center
- Private dental center
- **Power analysis:**

Figure (2) showing putty cast

A power analysis was designed a total number of 45 (15 in each group) is calculated using Epicalc program version 1.02 assuming a power of 80 % and alpha=0.05. The sample size is based on; mean± SD of fracture resistance in control group & TAC group was (2260.93± 540.2) & (1723.84 ±453.9), respectively. [7]

1. **Teeth selection and grouping:**

Figure (3): A-REE model

Forty-five anatomically precise maxillary first permanent molar, radiolucent model teeth (ANA-4 ZPURN) made of hard thermosetting plastic material to simulate pulp canal space with anatomical roots with which all steps of a root canal treatment can be simulated. Model teeth can be prepared and filled like a natural tooth (Farsaco, GmbH, Oberhofer, Germany). The teeth (n=45) were randomly allocated into 3 groups as follows: **Group I:** Dynamic Navigation (Navident) guided access **DN**, **Group II:** Static Navigation guided access **SN, Group III:** Conventional access. (figure 1)

2. **Specimen preparation:**

- **Group I**: teeth are embedded in radiopaque silicon based material preformed in a U shape to mimic an artificial jaw. During setting of putty cast, each tooth is inserted into the mold 2mm beyond CEJ. A rotary file is placed at the mesiobuccal side of each tooth to act a reference point for Navident during planning (figure 2) **Group II and III**: teeth are securely positioned in the model (A-REE model) with Philips head screws (Farsaco, GmbH, Oberhofer, Germany) (figure 3)

CBCT scans taken for all mounted treatment teeth with the following exposure parameters: a 60-kV peak, 2.0 mA, 15.0 seconds, and a 75-mm voxel size. Pulp chamber volume is calculated using 3D Slicer.

3. **Access cavity preparation:**

Group **(**I): Access cavities were made under full guidance of the second-generation Navident (ClaroNav, Toronto, Ontario, Canada) workflow[8, 9] . (figure 4):

a) Scanning

b) Planning: planning of the access cavity was performed by using a dedicated software for implant planning (Navident dynamic navigation system) (figure 5)

c) Tracing & calibration: Matching the CBCT images with the artificial jaws where replicas were placed through an optical tracer, the 6 markers were selected on the putty cast and coincided with the selected ones during the planning step to improve accuracy, This “Trace Registration” provided an accurate position of the tooth and the canals at any time during the procedure. (figure 6)

The teeth surfaces were traced with a tracer tool (jaw tag) that was also tracked by an optical positioning sensor. During the tracing, the system continuously sampled and recorded the points on the traced teeth: these points were then matched with the CBCT data. A final accuracy check was then performed to ensure the precision of this critical step. (figure 7)

The handpiece and burs were calibrated. The handpiece, tracked by the system (hand piece tag), was calibrated, the axis was calibrated first, followed by the calibration of the burs’ tips. This allowed the system to continuously track the bur’s direction and position, and to report it to the operator in real time on the computer screen. (figure 8)

Figure (4): Navident

d) Placing dynamically navigated access

Group (II): The SN study group first underwent preoperative CBCT scan. Afterwards, a 3D surface scan was performed with a 3D-intraoral scanner (3shape, terios) . Datasets obtained from the digital workflow were uploaded to 3D implant planning software (Exocad) to design the virtual template after matching the 3D surface scan and CBCT data, aligning the key points of the crown of the teeth. An implant bur length and diameter was measured to design the sleeve for each canal using the implant planning software to create an access cavity inside each tooth with a diameter of 1.2 mm, a total length of 20 mm, and a drilling depth of

11mm to enhance direct access to the root canal system. After designing the virtual template, it was fabricated by means of stereolithography technique (Formlabs model form 2 SLA 3D printer). Afterwards, template fitting was checked, three templates for each tooth and access cavities were made to a depth of 11 mm from the occlusal border (figure 9). [81011]

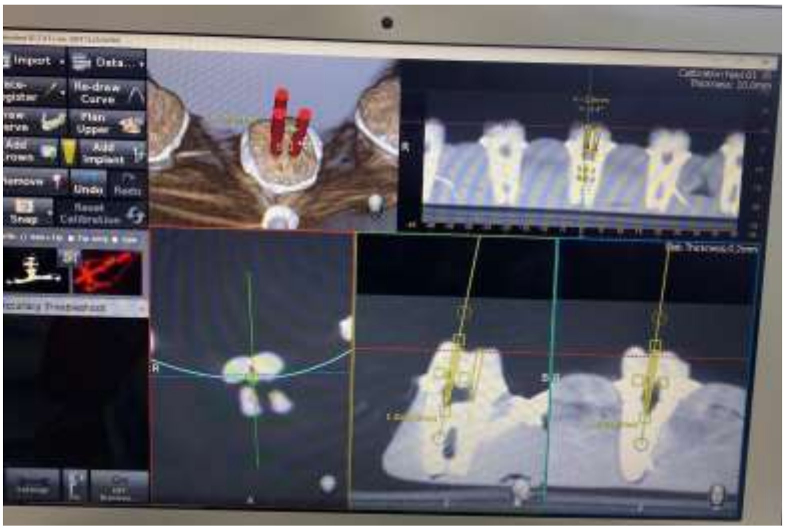
Group (III): The accesses were performed under a dental operating microscope (Carl Zeiss, Extaro, Germany). Traditional access outline of maxillary molar was done, triangular in shape with its base towards buccal surface extending from the mesial marginal ridge till the oblique ridge. Access cavity was done by complete de-roofing of the pulp chamber with exposure of all pulp horns and straight-line access into the canals.

4. Access time measurement:

Using a chronometer, the amount of time needed to access group I, II, and III was measured in seconds. The term “instrumentation time” refers to the total amount of time that was spent since the beginning of drilling till checking the canal orifice using #10 K-file.

5. Evaluation of amount of dentin lost:

- Pulp chamber volume is calculated using 3D Slicer after access cavity. (figure 10)
- The amount of dentin lost is evaluated by calculating the difference between pulp chamber volume before and after access (%).[1213]



Figure(5): planning software

Figure(6): confirming six registration landmarks

Figure (9): fitting of three templates for a molar

Figure(8): contra calibration

Figure(7): jaw tracker

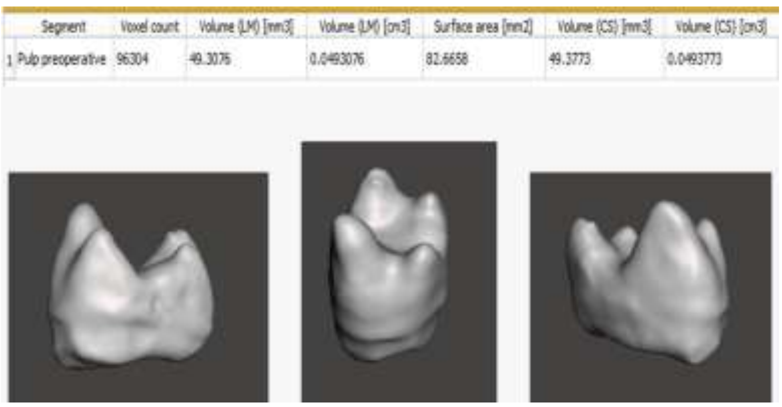


Figure (10): amount of dentin lost

Statistical analysis

Categorical data were presented as frequency and percentage values and were analyzed using Fisher's exact test. Numerical data are presented as mean and standard deviation values. They were checked for normality and variance homogeneity by viewing the distribution and using Shapiro-Wilk and Levene's tests, respectively. The data were found to be normally distributed; however, the assumption of homogeneity was violated for access time and lost dentine data. Therefore, fracture resistance data were analyzed using one-way ANOVA followed by Tukey's post hoc test, while other data were analyzed using Welch's one-way ANOVA followed by the Games-Howell post hoc test. Correlation analyses were performed using Pearson's correlation coefficient. The significance level was set at p<0.05 within all tests. Statistical analysis was performed with R statistical analysis software version 4.4.3 for Windows

2. RESULTS

1- Access time:

Intergroup comparisons and summary statistics of access time (mm:ss.ms) are presented in Table (1)

There was a significant difference between different groups (f=371.15, p<0.001), and the effect size was large (0.966). The highest mean time was found in group (III) (02:28.65±00:15.7), followed by group (I) (01:35.88±00:07.74), while the lowest time was found in group (II) (00:32.66±00:09.04). All post hoc pairwise comparisons were statistically significant (p<0.001).

TABLE (1) Intergroup comparisons and summary statistics of access time (mm:ss.ms).

Access time (Mean±SD) (mm:ss.ms)			f-value	p-value	PES (95% CI)
Group (I)	**Group (II)**	**Group (III)**			
01:35.88±00:07.74^{B}	00:32.66±00:09.04^{C}	02:28.65±00:15.7^{A}	**371.15**	**<0.001***	0.966 (0.936 to 0.974)

*PES Partial Eta Squared, CI Confidence interval values with __different superscripts__ are significantly different; * significant*

Table (2): Intergroup comparisons and summary statistics of lost dentine percentage.

Lost dentine percentage (Mean±SD)			f-value	p-value	PES (95% CI)
Group (I)	**Group (II)**	**Group (III)**			
62.07±12.59^{B}	10.14±4.91^{C}	137.33±9.08^{A}	**1130.71**	**<0.001***	0.989 (0.979 to 0.992)

PES Partial Eta Squared, CI Confidence interval; values with **different superscripts** are significantly different; * significant.

2- Percentage of dentin lost:

Intergroup comparisons and summary statistics of lost dentine percentage are presented in Table (2)

There was a significant difference between different groups (f=1130.71, p<0.001), and the effect size was large (0.989). The highest mean lost dentine was found in group (III) (137.33±9.08) (%), followed by group (I) (62.07±12.59) (%), while the lowest value was found in group (II) (10.14±4.91) (%). All post hoc pairwise comparisons were statistically significant (p<0.001).

3. DISCUSSION

In nonsurgical root canal treatment, the removal of tooth structure needed to prepare the access cavity can weaken the tooth up to 63%. Recently, the concepts of conservative and ultraconservative "ninja" endodontic cavity preparations have emerged. [8] However, there are some cases in which these new approaches for freehand access cavity preparation are difficult to achieve, as in teeth with pulp canal calcification or anatomical abnormalities. In these cases, the use of guided access based on cone-beam computed tomography (CBCT) may reduce the risk of iatrogenic complications and preserve the coronal structure of the tooth. [14]

The aim of the present study was to compare between two computer guided access cavity designs: Dynamic Navigation Access and Guided Access with Traditional Access Cavity.

In the present study, there was a significant difference between different groups, the highest mean time was found in

Conventional access group followed by Dynamic navigation group, while the lowest time was found in Static guided group. The cause behind consuming more time in DN group than SG group goes back to the operating system that continuously track the bur's direction and actual position and report it to the operator in real time on the computer screen (trace registration) fulfilling real-time guidance feedback, in addition to the precision of applying the planned access cavity by the operator. Further, there is a long learning curve for the practitioner when working with the DN because the technique requires a certain level of technical skill, hand-eye coordination and manual dexterity.[15 16]

These results came in line with Dianat et al. (2020) [13] who found less time required to prepare access cavities in the Dynamic navigation group than manual group. Another study done by Jain et al (2020) [9]came in line with this study results in which dynamically navigated accesses were prepared

The three techniques were compared in respect to the percentage of hard tissue removal. The results of the present study revealed that there was a significant difference between different groups in the percentage of lost dentin, the highest mean lost dentine was found in Conventional group followed by DN group, while the lowest value was found in SG group. This may be attributed to inadequate transfer of the anatomic landmarks during the tracing step, rectification of the orientation midtreatment or inadequacy with recalibration may induce unplanned tissue removal in dynamic guided access.

Results of the current study correlate with Jain et al. (2020) [9] who performed a study to compare free hand access and dynamic navigated access. Moreover, Dianat et al. (2020) [13] stated that DN group had significantly less dentin removal than the free hand group. Another study conducted by Janabi et al. (2021) [17] concluded that DN technique had significantly less volumetric loss of tooth structure than the free hand technique.

4. CONCLUSIONS

Within the limitations of the present study, it can be concluded that static guided access is a promising system for access preparation. It showed the shortest time that has a strong impact on patients' compliance

REFERENCES

[1] Zhang Y, Liu Y, She Y, Liang Y, Xu F, Fang C. The Effect of Endodontic Access Cavities on Fracture Resistance of First Maxillary Molar Using the Extended Finite Element Method. *J Endod*. 2019;45(3).

[2] Jain SD, Saunders MW, Carrico CK, Jadhav A, Deeb JG, Myers GL. Dynamically Navigated versus Freehand Access Cavity Preparation: A Comparative Study on Substance Loss Using Simulated Calcified Canals. *J Endod*. 2020;46(11):1745-1751.

[3] Chong BS, Dhesi M, Makdissi J. Computer-aided dynamic navigation: a novel method for guided endodontics. *Quintessence Int*. 2019;50(3).

[4] Dhesi M, San Chong B. Dynamic navigation for guided endodontics: a case report. *Endo-Endodontic Practice Today*. 2020;14(4).

[5] Widmann G. Image-guided surgery and medical robotics in the cranial area. *Biomed Imaging Interv J*. 2007;3(1).

[6] Camarillo DB, Krummel TM, Salisbury JK. Robotic technology in surgery: Past, present, and future. *Am J Surg*. 2004;188(4 SUPPL. 1).

[7] Abou-Elnaga MY, Alkhawas MBAM, Kim HC, Refai AS. Effect of Truss Access and Artificial Truss Restoration on the Fracture Resistance of Endodontically Treated Mandibular First Molars. *J Endod*. 2019;45(6).

[8] Zubizarreta-Macho Á, Muñoz A de P, Deglow ER, Agustín-Panadero R, Álvarez JM. Accuracy of computer-aided dynamic navigation compared to computer-aided static procedure for endodontic access cavities: An in vitro study. *J Clin Med*. 2020;9(1).

[9] 9. Jain SD, Saunders MW, Carrico CK, Jadhav A, Deeb JG, Myers GL. Dynamically Navigated versus Freehand Access Cavity Preparation: A Comparative Study on Substance Loss Using Simulated Calcified Canals. *J Endod*. 2020;46(11):1745-1751.

[10] D GT, Saxena P, Gupta S. Static vs. dynamic navigation for endodontic microsurgery - A comparative review. *J Oral Biol Craniofac Res*. 2022;12(4).

[11] Ribeiro D, Reis E, Marques JA, Falacho RI, Palma PJ. Guided Endodontics: Static vs. Dynamic Computer-Aided Techniques—A Literature Review. *J Pers Med*. 2022;12(9).

[12] Connert T, Krug R, Eggmann F, et al. Guided Endodontics versus Conventional Access Cavity Preparation: A Comparative Study on Substance Loss Using 3-dimensional–printed Teeth. *J Endod*. 2019;45(3).

[13] Dianat O, Nosrat A, Tordik PA, et al. Accuracy and Efficiency of a Dynamic Navigation System for Locating

Calcified Canals. *J Endod*. 2020;46(11):1719-1725.

[14] Zehnder MS, Connert T, Weiger R, Krastl G, Kühl S. Guided endodontics: accuracy of a novel method for guided access cavity preparation and root canal location. *Int Endod J*. 2016;49(10).

[15] Torres A, Boelen GJ, Lambrechts P, Pedano MS, Jacobs R. Dynamic navigation: a laboratory study on the accuracy and potential use of guided root canal treatment. *Int Endod J*. 2021;54(9).

[16] Panchal N, Mahmood L, Retana A, Emery R. Dynamic Navigation for Dental Implant Surgery. *Oral Maxillofac Surg Clin North Am*. 2019;31(4).

[17] Janabi A, Tordik PA, Griffin IL, et al. Accuracy and Efficiency of 3-dimensional Dynamic Navigation System for Removal of Fiber Post from Root Canal–Treated Teeth. *J Endod*. 2021;47(9):1453-1460.