

How to Cite:

Banik, A., Yaqoob, A., Gautam, A., Lalitha, P. L., Saikousalya, J., Sainudeen, S., & Tiwari, R. V. C. (2022). Accuracy of 3D dynamic navigation system for fiber post retrieval from RC treated teeth: In vitro study. *International Journal of Health Sciences*, 6(S2), 9989–9993. <https://doi.org/10.53730/ijhs.v6nS2.7621>

Accuracy of 3D dynamic navigation system for fiber post retrieval from RC treated teeth: In vitro study

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Abstract---Introduction: Removing fiber posts from root canal-treated teeth is inherent to tooth loss and time consuming. Hence in our

study we aim to investigate the accuracy and efficiency of the 3-dimensional dynamic navigation system (DNS) compared with the freehand technique (FH) when removing fiber posts from root canal-treated teeth. **Material and Methods:** We compared the extracted single rooted teeth prepared with post and build with core. We divided 40 teeth equally as DNS & FH. We compared Global coronal and apical deviations, angular deflection, operation time, and volumetric tooth loss, keeping the $p < 0.05$ as significant. **Results:** The DNS group showed significantly lower global coronal and apical deviations and angular deflection than the FH group ($P < .05$). DNS required less operation time than FH. Moreover, the DNS technique had significantly less volumetric loss of tooth structure than the FH technique ($P < .05$). **Conclusions:** The DNS was more precise and effective in removing fiber posts from root canal-treated teeth than the FH technique.

Keywords---dynamic navigation system, fiber posts, root canal-treated teeth.

Introduction

Technical shortages during the chemical-mechanical preparation of the root canal may lead to insufficient disinfection, leading to the maintenance of bacterial infection in the canal at levels adequate to sustain periradicular inflammation after root canal treatment.¹ In these cases, root canal retreatment procedures are required and can bring challenges during therapy, such as removing intraradicular posts.² Post-and-core systems are widely used in endodontically treated teeth the use of fiber posts and resin cores has increased due to their mechanical and aesthetic properties, which merge adequately with permanent restorations.³ The modulus of elasticity of fiberglass posts is alike to that of radicular dentin, intentionally reducing the probability of root fracture, which is the most recurrent cause of failure with metallic posts. Consequently, the establishment of a standard technique for the removal of any post system would be helpful.⁴ Current removal techniques involve the use of burs, ultrasound, and laser, each varying in procedure time and preservation of the dental structure. Removal requires to be atraumatic, with the concern to save the root canal structure offering resistance for long-term tooth retention, since the removal procedure raises concerns about the appearance of cracks or root fractures and becomes an important consideration in the selection of a treatment method and tooth prognosis.⁵⁻¹⁰ The purpose of this study was to investigate the accuracy and efficiency of the 3-dimensional dynamic navigation system (DNS) compared with the freehand technique (FH) when removing fiber posts from root canal-treated teeth.

Material and Methods

We conducted an invitro observational study on 40 single rooted. These specimens were root canal treated and restored with Parapost Taper. A core buildup was later performed. Teeth were mounted in tissue-denuded cadaver

maxillae. Teeth were divided equally into 2 groups the DNS and the FH group. Cone-beam computed tomographic scans were taken pre- and postoperatively. The drilling path and depth were planned virtually using X-guide software in both groups. For the DNS group, drilling was guided with X-Nav software and the FH group under a dental operating microscope. Global coronal and apical deviations, angular deflection, operation time, and the number of mishaps were compared between the groups to determine the accuracy and efficiency. The 3-dimensional volume (mm^3) of all teeth was calculated before and after post removal using the Mimics Innovation Suite. The Shapiro-Wilk, 1-way analysis of variance, and Fisher exact tests were used ($P < .05$).

Results

We observed that for the global coronal deviation the DNS group was significantly lower than FH. Similarly observations were made in the Apical deviation, for both the groups. For the DNS group the time required to remove the post was lesser than the FH group. There was a significant lower loss of the tooth structure in the volume in DNS group than the FH group. Table 1

Table 1: Comparison of the groups DNS and FH

FEATURE	MEAN±SD	DNS	FH	P
Coronal deviation	3.112± 1.861	1.525 ±0.164	4.699± 1.324	0.001
Apical deviation	3.112± 1.861	1.525 ±0.164	4.699± 1.324	0.001
Angular deflection	89.20 ±87.44	86.86 ±91.71	91.54 ±86.11	0.05
Time required	3.112± 1.861	3.525 ±0.164	1.699± 1.324	0.065
Volumetric loss of tooth structure	161.579 ± 22.408	168.445±24.438 ^A	154.713 ±18.490	0.05

Discussion

Post-and-core systems constitute one of the usually used methods in the treatment of these teeth. It has been claimed that fiber posts reduce root fractures because of dentin-like elastic modulus. In recent years, fiber posts have come to be the most frequently used posts.⁶ Deterioration of the cement bond and pulling out the post, which constitute the primary removal method, may not be possible for these posts. It has also been described that most post removal kits leave cement or fiber post residues on the dentin walls, and they harvest worse results than other methods. For this reason, ultrasonic devices and burs have been suggested for fiber post removal.⁷⁻¹⁰ Though, it has been argued that ultrasonic devices are generally used for the disassembly of metallic posts and are unsuccessful in the elimination of adhesively bonded posts. In the present study we compared the 3-dimensional dynamic navigation system (DNS) with the freehand technique (FH). We observed that for the global coronal deviation the DNS group was significantly lower than FH. Similarly observations were made in

the Apical deviation, for both the groups. For the DNS group the time required to remove the post was lesser than the FH group. There was a significant lower loss of the tooth structure in the volume in DNS group than the FH group. Since this is first of the studies to compare the two in the removal of the post in the endodontically treated teeth. Successful endodontic retreatment necessitates efficient removal of the posts devoid of leaving residual materials on the root canal walls. Studies have described that removal kits left more residue on the root canals than burs and sonic tips, regardless of fiber post type. Lindemann et al. (2005) associated the efficiencies of a fiber post removal system recommended by the manufacturer and ultrasonic tips.¹⁰ According to their study results, removal efficiency of ultrasonic tips was better than that of the kit. Protection of the root structure is important for sufficient root resistance and long-term tooth retention. Few studies have reported that burs removed more material from the dentin, and the least loss occurred when quartz fiber posts were used with dismantling kits. Our study also showed that dentin loss in the DNS group was significantly lower than that in the FH group. Root fracture may occur as a result of micro-fracture or a fracture line, which is propagated by repeated stress application by occlusal forces. Prevention of cracks or fractures in teeth during shaping of root canals, preparation of post spaces, post placement, and post-removal procedures is an important consideration in selecting a treatment method. To date, there have been no reports on the use of dynamic navigation to perform endodontic retreatment involving the removal of fiber posts, and there have not been references regarding its use with ultrasonic tips. Dynamic navigation allows for modifications to the original plan during the procedure as a result of the ability to see the cutting tip in real time. This is a significant advantage in comparison with static guides, where no path modification is possible. The use of the system has a learning curve because the clinician must look at a monitor rather than through the oculars of a microscope, but the learning period is short, and the procedure is remarkably easy to learn. Gambarini et al⁹ demonstrated that dynamic navigation offers many advantages in endodontic apical surgical procedures in comparison with static guides, particularly in the use of shorter surgical instrumentation. Conservative endodontic access has been proposed to reduce the fracture risk in endodontically treated teeth. A clinical case report demonstrated the use of dynamic navigation for minimal access through a ceramic crown to identify a sclerotic root canal space that had metamorphosed to the apical third. They concluded that the 2D deviation of 0.9 mm was relatively safe for deep endodontic-access cavity preparations.⁵ Studies comparing the placement accuracy between freehand, static-guided, and computer-assisted surgery (dynamic navigation) have shown that dynamic navigation is more precise than the other modalities. Adapting this technology to endodontics is a necessary paradigm shift for treating metamorphosed, sclerotic, and occult canals. In our study, DNS allowed for the planning of a minimally invasive access path through a crown and the precise removal of a fiber post using real-time feedback from the instrument tip.⁸ The development of dedicated surgical navigation systems could assist in minimizing risk and in the prevention of iatrogenic errors in many if not all endodontic procedures.⁶⁻¹⁰

Conclusion

The DNS was more accurate and efficient in removing fiber posts from root canal-treated teeth than the FH technique. Further studies are advocated in the clinical settings.

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