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Dynamic Navigation System - A current Breakthrough in Dentistry

Research Article

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Abstract

Dynamic navigation systems were introduced to facilitate dental implantology by improve the accuracy of dental implant positioning. It integrates surgical instrumentation and radiologic images by using an optical positioning device controlled by a dedicated computerized interface. These features could help in reducing the risk of unintentional iatrogenic damage to nearby anatomic structures and perform minimally invasive or a flapless surgery, leading to reduced patient postoperative discomfort and improved healing. By use of the navident dynamic navigation system, this system allows precise localization of the root and precise apicoectomy with a minimal invasive cavity. The navigation system allowed the operator to precisely performs a minimally invasive osteotomy and root- end resection during endodontic surgery. The development of dedicated surgical navigation systems for endodontic surgery could facilitate the operator's maneuvers and reduce the risk of iatrogenic errors.

Introduction

The Dynamic Dental Navigation System- The Next Generation of Endodontics

In today's fast-moving, competitive world, we are always on the lookout for the quickest, most convenient, and most accurate method of treatment. Root canal therapy is a very common endodontic treatment that saves a tooth when nerves are affected by decay or infection [1]. Recent technological advances have improved the accuracy of root canal therapy and increased the overall satisfaction to the patients. Recently a new device has been introduced in the field of Implantology [2]. This new technology is known as The Dynamic Dental Navigation System, the introduction of this technology, a static guide (CAD/CAM), using a prefabricated stent based on a CBCT scan was manufactured to guide the surgeon in the safe placement of the implant [3]. Dynamic Navigation uses a stereoscopic tracking camera to dynamically guide the operator's instruments to the correct location for the implant placement in real time. Dynamic Dental Navigation System, the newest and most advanced 3D navigational system reported to be more accurate than free- hand placement of implants [1]. Dr. David Burgess describes this technique as " just like a GPS guides drivers"advantages of using this technology such as improved safety & aesthetics, minimally invasive, less patient discomfort and faster recovery time [4]. This technology has gained an attention of the endodontist and could be uniquely suited for the treatment of complex cases both conventional and surgical. When faced with calcified canals., multiple canals, difficult to locate canals and unusual anatomy on a daily basis this system could be used for finding and successfully treating these canals in a safe and predictable manner. In addition, this technology potentially can be used to make smaller, less invasive access preparations as well as a safer option for apical surgery. This technique proves to be very effective in locating canals and in creating smaller less invasive access preparations. Adding this latest form of digital scanning software to our current capabilities has significantly enhanced the effectiveness of our root canal treatment.

Previously our team has a rich experience in working on various research projects across multiple disciplines [5-19] Now the growing trend in this area motivated us to pursue this project.

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The Benefits

Dynamic 3D Navigation provides a variety of benefits for our endodontists and patients. The advantages are :-

- Saves time-single visit treatment.
- Improves accuracy.
- Provides same-day surgery options.
- Allows for complete treatment in one location.
- Reduces cost-multiple guides and visits are no longer necessary.
- Supplies easier access to posterior teeth

ClaroNav (ClaroNav Inc, Toronto, ON, Canada) has been working at creating a similar application of their own. Their Dynamic Navigation for Implants (Navident) offers dental surgeons an easy to use, accurate, highly portable and affordable way to plan the desired restoration and implant placement on a virtual patient and then execute the plan on the patient's jaw in real time. With their latest software release (Navident 2.1) this system offers:

• No need for a Fiducial, hence no need for a special (sometimes second) CBCT scan
• Works with a small Volume CBCT
• Works with any DICOM file from any CBCT machine
• No need for a second scan
• Head-Tracker for Maxillary area
• New Calibrator tool that enables the calibration and use of low and high-speed handpieces as well as piezotome saws.
Navident has also been conducting "in vitro" testing of this software for its use in endodontics.

The Navigation System Process

Dynamic 3D Navigation is an interactive protocol which aids the operator in improving precision and acces. It implements a 3D treatment plan by accessing the Navigation System's live, 360-degree view of drill position and oral anatomy. This cutting-edge technology assists in our achieving consistent and desirable results, as it provides our doctors with one dynamic focus point: the screen.

The computer navigation software provides an alternative to static drill guides (CAD/CAM). Working in real-time, rather than requiring hours of planning and fabricating before a patient's appointment, the Navigation System consists of an overhead 3D camera that focuses on the endodontist's handpiece and the patient's jaw. The computer calculates the positions of the handpiece relative to the jaw, and the doctor focuses on the screen which displays a target-like graphic.

This new technology eliminates numerous difficulties encountered when using static drill guides, and proves most effective in more complex cases, such as calcified pulp chambers and canals. Dynamic Navigation also has the potential for assisting our doctors in cases where apical surgery is indicated. This will positively impact the way we carry out root canal treatment, by helping to locate very calcified canals with much smaller access while preserving more tooth structure. In a single visit, thanks to X-NAV Technologies, our endodontists can precisely and confidently drill through solid dentin roots, disinfecting and restoring teeth, one smile at a time.

Computer-guided endodontics is a new and exciting field of dental surgery, and the Navigation System is a tool that allows our doctors to see - via a computer screen – into your mouth as they operate. Dynamic 3D Navigation scans, navigates, and – similar to a GPS - directs our doctors to exact locations as they plan and perform surgery. Dynamic 3D Navigation is simply a tool that requires the skill and experience of an expert endodontist.

Advantages Of Dynamic Navigation

Navident can calibrate and track both high-speed and low-speed driven burs, piezotome saws and other rigid instruments such as osteotomes or even a dental or an endodontic probe, enabling the clinician with the use of any such device for access opening and surgical procedures.

The Trace Registration method (commercially known as "TaP" = "Trace and Place") allows the dentist to register the CBCT scan to the patient by selecting three to six radiographically distinct, accessible landmarks on the screen, then tracing them in the patient's mouth. This method eliminates the need for a special second scan to be taken with a metallic fiducial-marker affixed to the jaw with a thermoplastic stent. Aside from reducing the exposure to radiation, it reduces the chance for errors caused by stent dislocation during the scan and allows for the use of a small volume CBCT. As a consequence, it also minimizes time and cost to the procedure.

Figure 1. Demonstrating the Navident unit used for Dynamic Navigation System.

Once the handpiece and the bur are calibrated, Navident dynamically presents on the screen the actual place and position where to initiate the access. It also shows where the tip of the bur is in real time, guiding the operator to the predetermined place to locate the canal making the location of calcified and multiple canals a faster and more accurate procedure.

Our institution is passionate about high quality evidence based research and has excelled in various fields [9, 20-29].

With the aid of this technology, smaller and more accurate accesses can be made. Preservation of valuable dentin is one of the main objectives when performing any dental procedure. In addition, this technology will allow for the location of canals that otherwise could not be detected and negotiated with more traditional techniques. Dynamic Navigation has also the potential for assisting the surgeon in cases where apical surgery is indicated.

Conclusion

In conclusion, the dynamic navigation system allowed the operator to precisely perform minimally invasive osteoctomy and root end resection during endodontic surgery. The development of dedicated surgical navigation systems could facilitate the operator's maneuvers and reduce the risk of iatrogenic errors. Comparing the Navident performance with the use of the microscope was very impressive. The computer navigation software performed very accurately. Dynamic navigation is an additional value chain in digital workflow sequencing. Minimally invasive protocols are the trajectory of dentistry's future.

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