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Navigation guided surgery: Precision in implant dentistry

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Abstract
Digital technology allows virtual treatment plans to be created and replicated with great accuracy during surgical procedures. In dentistry, the dental implant surgery with the use of dynamic navigation system provides accurate placement of the implant system. When implemented with an efficient workflow, the use of dynamic navigation leads to enhanced profitability and predictably of treatment outcomes in dental implant surgery.

Keywords: elastic modulus, flexural strength, provisional restorative materials

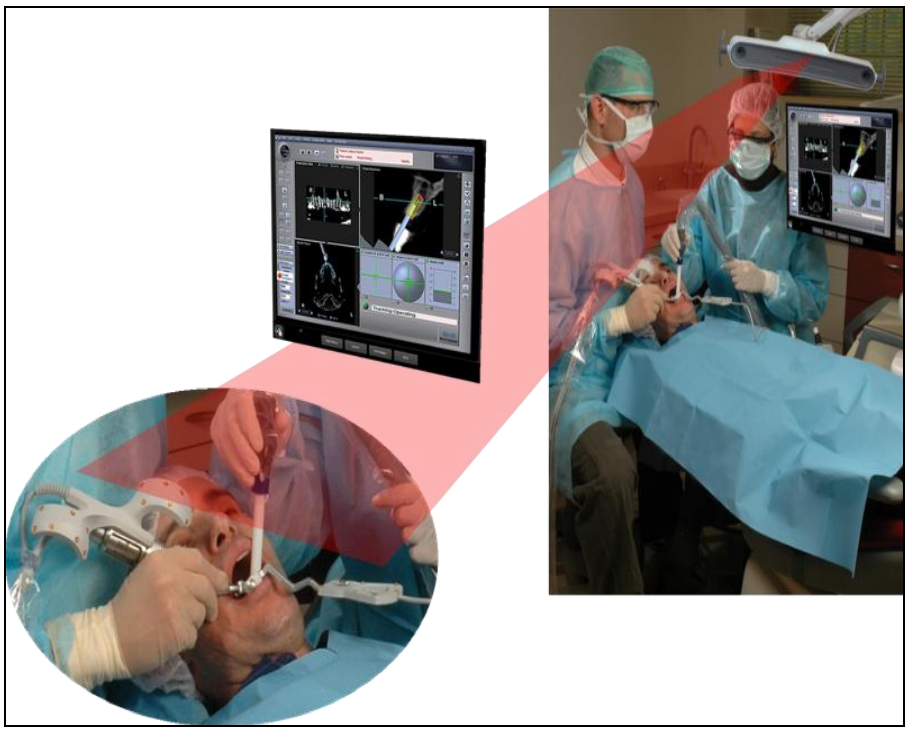
Introduction
Image-guided Surgery, or IGS, refers to surgery where preoperative imaging is used together with intraoperative tracking, and in some cases intraoperative imaging, to guide the surgical procedure. The preoperative image data is associated with, or registered to, the patient, so that tracked instruments and patient anatomy can be shown in the context of the preoperative image data and surgical plan. Image-guided surgery is typically a cone-beam computed tomograph (CBCT), is merged with computer-based planning tools to facilitate surgical and restorative plans and procedures. The patients typically have a CBCT preoperatively with or without a radiographic template in place. The radiographic template outlines the proposed ideal prosthetic outcome relative to anatomic structures and topography.
IGS starts with acquisition of tomographic images from the patient, At the start of surgery, preoperative imaging and medical instruments are associated with the patient. Identification of the corresponding anatomical landmarks on both the anatomy of the virtual and real patient are done to obtain images during surgery and registers them to the preoperative images .Once the virtual and real patient are aligned, medical instruments are tracked with respect to the patient by employing one or more of the four main tracking technologies :

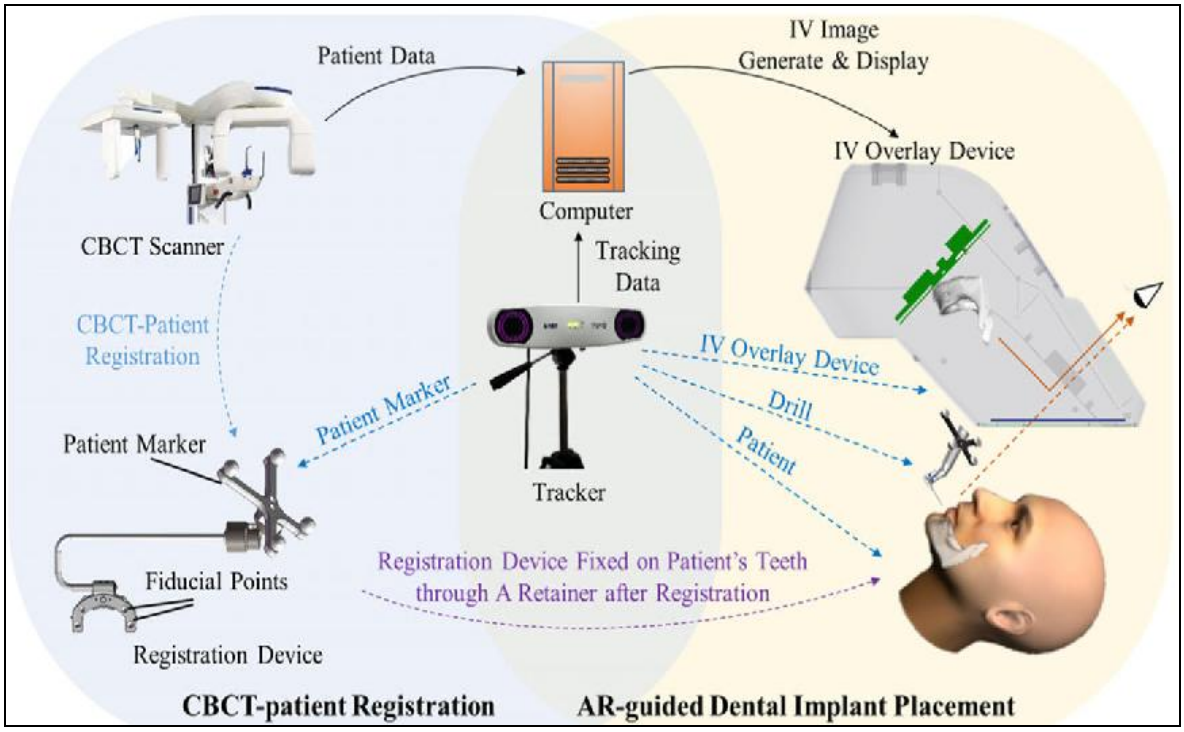
- **Optical Tracking** - Passive or active (light-emitting) markers are localized using video cameras, often in a stereo configuration.
- **Electromagnetic Tracking** - Active markers affect an imposed electromagnetic field, thus enabling their three-dimensional localization.
- **Ultrasound Tracking** - Active or passive markers are localized by measurement of their ultrasonic echoes.
- **Mechanical Tracking** - Instruments are attached to mechanical arms, enabling their localization through reading out the angles of the joints.

Navigation Guide Surgery in Dental Implant Placement
A dental implant restores chewing function, has superior biomechanics and aesthetics, and facilitates efficient long-term care. A well-positioned dental implant is based on the appropriate placement of the implant, a prosthetic-driven concept that highlights the importance of the implant placement, angle, and direction. As the oral cavity is composed of special structures, adequate information must be obtained before performing implant surgery to plan the implant location and depth, which improve the success rate, and reduces possible sequelae from the implant surgery.

Navigation systems can improve safety during surgery and prevent damage to nerves or critical structures of adjacent teeth. By using this system, dentists can develop a precise plan for dental implants according to preoperatively derived data, thereby increasing the accuracy of dental implants and reducing the risk of dental implant failure. Clinical experiences have confirmed that dental implant navigation systems are reliable and can be routinely used in dental implant surgery.

How it works

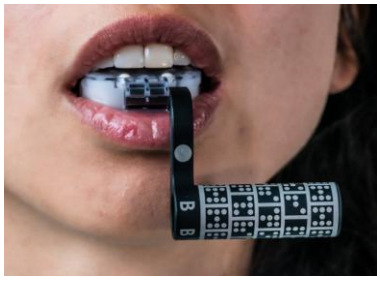




The navigation procedure can be divided into three parts:

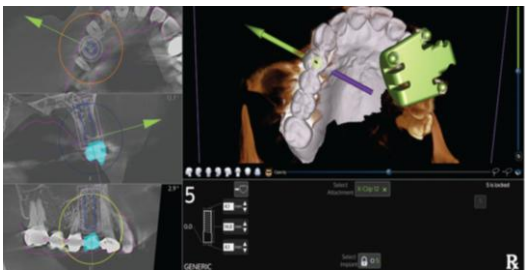
Patient Implant Diagnostic Appointment

In this time lapse, optical imaging is taken using an X- guide. The X-Guide uses a passive optical system that requires tracking arrays from the patient and the handpiece to be in view of its stereo cameras so the information can be relayed to the monitor. The patient array is attached to the patient via an X-guide which is molded onto the patient's dentition and worn during the cone beam CT scan. Once the CBCT is acquired, the X-Clip can be removed and stored for surgery to be done at a later date. If implants are planned for both arches, both maxillary and mandibular clips may be placed at the same time for the CBCT intraoral scans may also be taken and imported in the treatment planning software.



Virtual Treatment Planning

As previously mentioned, intraoral scans may be uploaded and aligned to the DICOM (Digital Imaging for Communication in Medicine). If a lower posterior implant is to be planned, the inferior alveolar nerve may be mapped. The software allows for a virtual wax-up of the proposed restoration and gives the user the ability to freely move it into position and change its dimensions. Once the virtual wax-up is complete, implant planning is done. The dental implants are planned accordingly their height and width being adjusted.



Dental Implant Surgery

Once the X-Guide system is calibrated and the X-Clip is properly placed on the patient's dentition, implant surgery can then proceed.

Flapless Implant Surgery

- One of the advantages of guided implant surgery is reduced complications associated with implant placement in flapless procedures compared with non-guided procedures. Brodala's systematic review of flapless implant surgical procedures concludes, "Flapless implant surgery appears to be a plausible treatment modality for implant placement, demonstrating both efficiency and clinical effectiveness."

Advantages

- Implant placement procedure that is safer and more accurate than traditional implant surgeries, increasing the reliability of dental implant treatment.
- With the use advanced, 3D imaging and virtual models, surgeons are provided with the ability to see the exact position and condition of critical structures, including the nerves, adjacent tooth roots and sinus cavities, before surgery, reducing risk of surgical complications.
- Bone quality and quantity can also be more accurately assessed during the planning phase, leading to increased dental implant success rates.
- The more precise implant placement that this technology enables also sets the stage for better aesthetic outcomes, making the restoration phase of treatment easier and more accurate.

Disadvantages

- Expensive CT machine is necessary.
- When doing a flapless surgery, the patient's bone situation cannot be assessed.
- The surgery planning time takes longer.
- The user must learn the planning software.
- Any unexpected situations during surgery are hard to be dealt with.
- Surgical kits and surgical templates must be purchased.

Conclusion

Navigation guided surgery is gaining interest because of its potential to improve patient outcome and shows that an excellent result can be obtained through the use of creating a precise virtual treatment plan and reproducing that by utilizing dynamic navigation.

This system provides highly accurate navigation in dental implantology. The accurate intraoperative navigation allows the surgeon to precisely transfer the presurgical plan to the patient.

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