INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

DYNAMIC NAVIGATION SYSTEM IN IMPLANTOLOGY-AN OVERVIEW.

Prosthodontics

Dr. N. Sanhitha* Post Graduate Student, Department Of Prosthodontics, Rajarajeshwari Dental College. *Corresponding Author

Dr. Srilakshmi J Professor, Department Of Prosthodontics, Rajarajeshwari Dental College.

Dr. Shwetha Kumari Poovani Professor & Head Of The Department, Department Of Prosthodontics, Rajarajeshwari Dental College

ABSTRACT

In today's fast-moving, competitive world, we are always on the lookout for the quickest, most convenient, and most accurate method of treatment. Dental implants need to be placed accurately at the proper depth, angulation, and crestal position. Optimal occlusion and preserving the health of the peri-implant tissues with good dental hygiene and appropriate implant loading are prerequisites for ideal implant implantation, which favours good aesthetic and prosthetic outcomes. Over the course of several decades implant dentistry has evolved to include 3-dimensionally (3D) planned and guided surgery. Dynamic navigation, one of the most recent advancements, may enable surgeons to place implants with precision comparable to stereolithographic guidance based on 3D, prosthetically driven designs. Nowadays, guided, full-arch, immediate-function therapy for the edentulous and terminally dentate patient is easier to administer and more predictable because of the development of intraoral surface scanners and computer-aided design/computer-aided milling (CAD/CAM).

KEYWORDS

Dental implants, Computer guided Implant Surgery, Static guides, Dynamic navigation.

INTRODUCTION

Dental implants are commonly used to replace lost teeth and have benefits over alternative restoration options such as bridges and dentures. Implants restore form and function without damaging adjacent teeth, stabilize alveolar bone, and have predictable long term outcomes.[1] Implants play a major role in determining the efficiency of the core practices among dental practitioners.[2] Implantologists have several options when it comes to implant planning and placement. This starts with evaluating the occlusion and placing the restorative envelope of the virtual teeth in the proper occlusal position.[3]

Radiographic and clinical exams are frequently used to aid in treatment planning.[4] Today's practitioner can benefit from Cone Beam Computed Tomography (CBCT) data interaction because it improves treatment planning assessment based on data including linear relative bone quality, 3D evaluation of ridge shape, and proximity to important anatomic structures.[5] The invention of static implant guides to provide predicted accuracy in implant placement was made possible by the integration of software and imaging.[3]

Complications Associated With Inaccurate Positioning Of Dental Implants

These include the following

- Damage to the inferior alveolar nerve
- Floor of mouth hematoma
- Damage to adjacent roots
- Sinus infections secondary to inadvertent sinus perforations
- Fractured implants due to off-axis loading
- Periimplantitis due to food impaction and off axis loading
- Poor esthetics secondary to thin buccal, labial bone
- Interproximal bone loss secondary to placing implants too close to adjacent teeth and implants
- Increased prosthetic complexity.[3]

Techniques for placing implants include the freehand approach, limited guidance using laboratory produced surgical guide stents made on models and computer assisted design/computer aided manufacturing(CAD/CAM)generated static guide stents that are either tooth, mucosa or bone supported.

Computer Assisted Implant Surgery

Computer-assisted surgery(CAS) for dental implant placement includes static and dynamic systems

- Static systems
- Dynamic navigation system.[6]

Static Systems

Static refers to an implant position that has been predetermined without being able to see the implant preparation site in real time. Static systems build stents with metal tubes using computer-aided design and manufacturing using CT images, while surgical systems use coordinated instrumentation to place implants using the guide stent. Without the option to alter the stent, the implant position is dependent on the stent (Fig 1). It is not possible to shift positions during surgery.[6,7]

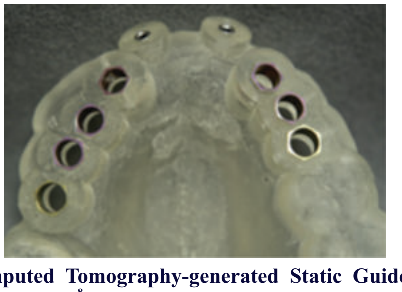

Fig1: Computed Tomography-generated Static Guide For An Edentulous Patient.[8]

The use of the CT-generated guide stent also limits the ability to irrigate the drill during the process, because access is limited to the bone, with the potential for increased heat production.[9] The use of static guides is difficult when the patient has limited mouth opening and when placement is required in the second molar regions. The costs of using CT-generated static stents include the cost of the software and the cost for fabrication of the CT-generated guide stent.[8]

Dynamic Navigation System

Dynamic Navigation makes use of systems working with a camera recording the position of the patient and a screen displaying the position of the drills onto Cone Beam Computer Tomography (CBCT) images in real-time during surgery and uses optical technologies to track the patient and the hand piece and displays the images onto a monitor(FIG 2).[8,10]

Fig2: Overview Of Dynamic Navigation System.[11]

Indications Of Dynamic Navigation
- Placement of implants in patients with a limited mouth opening.
- Placement of the implant on the same day of the CBCT scan.
- Placement of implants in difficult-to-access locations such as the second molar.
- Placement of implants when direct visualization will be difficult.
- Placement of implants in tight interdental spaces when static guides cannot be used owing to tube size.
- Placement of implants adjacent to natural teeth in situations in which static guide tubes will interfere with ideal implant placement.[8]

Advantages Of Dynamic Navigation
- Real-time feedback
- Accurate
- Takes Less time
- A streamlined digital workflow
- Improved surgical visualization
- Adaptability to intraoperative findings.
- Ability to change the implant size, system, and location during the surgical procedure.[12,13]

It also requires less-invasive flap reflection compared with free-hand approaches and results in less trauma to the surgeon because the surgeon's posture is improved, with less back and neck bending.[8]

Treatment Protocol For Dynamic Navigation
The workflow consists of following three steps
(1) Plan—The creation of a virtual surgical plan on the basis of the volumetric DICOM (Digital Imaging Communication in Medicine) data acquired from a CBCT scan.
(2) Trace—The registration of the patient's jaw to their CBCT. This is done by tracing high contrast landmarks selected/marked on the CBCT.
(3) Place—The implant placement is navigated according to the plan.[14]

(1) PLAN
The DICOM files (from the CBCT) and the stereolithography (STL) files (from the IOS) were merged into the Navident software and overlapped semi-automatically to the residual teeth using the provided mesh-to-image registration tool.[15]

(2) TRACE
In order to track the patient's jaw, an optical tracking tag needs to be affixed to the jaw on which the surgery has to be performed. This requires a JawTracker to be connected to 1–2 teeth in the residual dentition with a light-cured composite resin. Alternatively, and only in the maxilla, a HeadTracker can be used to track the maxilla by placing it directly on the patient's head (Fig 3). Then, tracing can be performed starting at the landmark locations.[14]

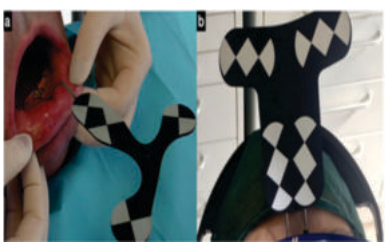

Fig 3:(a)jaw Tracker Anchored With Three Bone Screws To Lower Jaw (b)head Tracker Used To Track The Maxillary Jaw.[14]

(3) PLACE
Drill axis and drill tip accuracy are verified and navigation of implant placement is carried out following the target view,which allows the clinician to verify,in real time, the entry point, depth, and angulation of the planned osteotomy as related to the plan.[14]

Fig 4: As Implant Drilling Occurs,depth Indicator Changes In Color From Green To Yellow When Drill Is 0.5mm From The Target Depth.yellow Turns To Red, Indicationg To Stop The Depth Of The Osteotomy.[3]

The drill and patient-mounted arrays must be within the line of sight of the overhead stereo cameras to be accurately tracked on the monitor. A small flap can be made, as needed, to expose the crestal bone.[15,16]

Fig5: Surgeon Using Naivgation Screen To Guide The Drill With Minimum Direct Visualisation Of The Drill In The Patients Mouth And Surgical Assistant Focusing On Irrigation, Retraction Suctioning.[8]

Drawbacks
The incorporation of CGIS(Computer Guided Implant Surgery), had led to some disadvantages like increased cost of treatment, added need for advanced equipment like Three Dimensional (3D) printers, increased treatment planning time and additional qualifications for operating such equipment.[17]

Summary
The increased utilization of these digital 3-D diagnostic and therapeutic modalities allows the surgical team to see the limitations of freehand surgery. CAS allows the implant team to overcome the limitations of human stereo vision and increase the accuracy and precision of implant placement. DN allows the surgeon to implement digital implant treatment plans in an efficient fashion. This efficiency and flexibility allow the team to utilize CAS on every implant in every patient.[3]

Dynamic navigation enables implant surgeons in getting accurate implant site preparation results.[18] In order to obtain a high level of patient-specific results, the use of virtual implant planning and subsequent navigation also enables prosthetic and surgical collaboration with precise planning and perfect orchestration of the plan.[8]

REFERENCES

1. Emery RW, Merritt SA, Lank K, Gibbs JD. Accuracy of dynamic navigation for dental implant placement–model-based evaluation. Journal of Oral Implantology. 2016 Oct;42(5):399-405.
2. Kalaivani G, Balaji VR, Manikandan D, Rohini G. Expectation and reality of guided implant surgery protocol using computer-assisted static and dynamic navigation system at present scenario: Evidence-based literature review. Journal of Indian Society of Periodontology. 2020 Sep;24(5):398.
3. Panchal N, Mahmood L, Retana A, Emery R. Dynamic navigation for dental implant surgery. Oral and Maxillofacial Surgery Clinics. 2019 Nov 1;31(4):539-47.
4. Bohner L, Prestes R, Mukai E, Mukai S, de Lima Romeiro R. Computer-Aided Implant Surgery: A Literature Review.
5. Rios HF, Borgnakke WS, Benavides E. The use of cone□beam computed tomography in management of patients requiring dental implants: an American Academy of Periodontology best evidence review. Journal of periodontology. 2017 Oct;88(10):946-59.
6. Block MS, Emery RW, Lank K, Ryan J. Implant Placement Accuracy Using Dynamic Navigation. International Journal of Oral & Maxillofacial Implants. 2017 Jan 1;32(1).
7. D'Souza KM, Aras MA. Types of implant surgical guides in dentistry: a review. Journal of Oral Implantology. 2012 Oct 20;38(5):643-52.
8. Block MS, Emery RW. Static or dynamic navigation for implant placement—choosing the method of guidance. Journal of Oral and Maxillofacial Surgery. 2016 Feb 1;74(2):269-77.
9. dos Santos PL, Pereira Queiroz T, Margonar R, de Souza Carvalho AC, Betoni Jr W, Rodrigues Rezende RR, dos Santos PH, Garcia Jr R. Evaluation of bone heating, drill deformation, and drill roughness after implant osteotomy: guided surgery and classic drilling procedure. International Journal of Oral & Maxillofacial Implants. 2014 Jan 1;29(1).

10. Nijmeh AD, Goodger NM, Hawkes D, et al: Image-guided navigation in oral and maxillofacial surgery. Br J Oral Maxillofac Surg 43:294, 2005
11. Wang X, Shujaat S, Meeus J, Shaheen E, Legrand P, Lahoud P, Gerhardt MD, Jacobs R. Performance of novice versus experienced surgeons for dental implant placement with freehand, static guided and dynamic navigation approaches. Scientific Reports. 2023 Feb 14;13(1):2598.
12. Mandelaris GA, Stefanelli LV, DeGroot BS. Dynamic navigation for surgical implant placement: overview of technology, key concepts, and a case report. Compendium of continuing education in dentistry,2018 Oct 1;39(9):614-21.
13. Schnutenhaus S, Edelmann C, Knipper A, Luthardt RG. Accuracy of dynamic computer-assisted implant placement: a systematic review and meta-analysis of clinical and in vitro studies. Journal of Clinical Medicine. 2021 Feb 11;10(4):704.
14. Stefanelli LV, Mandelaris GA, Franchina A, Pranno N, Pagliarulo M, Cera F, Maltese F, De Angelis F, Di Carlo S. Accuracy of dynamic navigation system workflow for implant supported full arch prosthesis: a case series. International Journal of Environmental Research and Public Health. 2020 Jul;17(14):5038.
15. Wang X, Shaheen E, Shujaat S, Meeus J, Legrand P, Lahoud P, do Nascimento Gerhardt M, Politis C, Jacobs R. Influence of experience on dental implant placement: an in vitro comparison of freehand, static guided and dynamic navigation approaches. International Journal of Implant Dentistry. 2022 Dec;8(1):1-9.
16. Strong EB, Rafii A, Holhweg-Majert B, Fuller SC, Metzger MC. Comparison of 3 optical navigation systems for computer-aided maxillofacial surgery. Archives of Otolaryngology–Head & Neck Surgery. 2008 Oct 20;134(10):1080-4.
17. LahotI K, DanDEKar S, GaDe j, agrawal m, agarkar a, khairkar r. Knowledge, Attitude and Practice of Dental Practitioners towards Computer Guided Implant Surgery in Central India: A Cross-sectional Survey. Journal of Clinical & Diagnostic Research. 2022 Jun 1;16(6).
18. Pellegrino G, Bellini P, Cavallini PF, Ferri A, Zacchino A, Taraschi V, Marchetti C, Consolo U. Dynamic navigation in dental implantology: The influence of surgical experience on implant placement accuracy and operating time. An in vitro study. International Journal of Environmental Research and Public Health. 2020 Mar;17(6):2153.