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Review Article

Surgical stent for implants- A review

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Abstract

The development of osseointegration has led to a significant increase in the use of dental implants in recent years. However, complications during implantation often arise due to factors such as inaccurate diagnosis, insufficient treatment planning, suboptimal surgical techniques, and improper implant placement. These issues can be mitigated by employing surgical guides to ensure precise implant positioning. While conventional surgical guides continue to be utilized, their clinical outcomes can be unpredictable. Even with correct implant placement, the location and alignment may not meet the optimal requirements for prosthodontic restoration. Achieving high accuracy in both planning and execution is crucial to ensure a high success rate and avoid iatrogenic complications. This level of precision can be attained through the use of computed tomography (CT), 3D implant planning software, image-guided template fabrication techniques, and computer-aided surgery. This article provides an in-depth evaluation of conventional surgical guide systems that rely on radiographic techniques, as well as newer, computer-generated surgical guides.

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1. Introduction

Dental implants have become a key solution for replacing missing teeth. In the early stages, implant positioning and angulation were largely determined by the quantity and quality of the available bone.[1] However, the development of prosthetically guided implantology emerged to address the need for more predictable outcomes. This approach involves planning the precise implant location during the diagnostic phase, based on the desired final restoration.[1] Placing implants near critical anatomical features poses technical challenges, as even small deviations can damage nearby structures or compromise the durability of the prosthesis.[2,3] Therefore, during implant surgery, it is essential to consider bone anatomy, the planned prosthetic outcome, and the proximity of vital anatomical structures when determining implant position and angulation. One way to enhance placement accuracy is through the use of radiographic stents during the planning phase and surgical guides during the procedure.[4,5] Incorporating a radiographic template with CBCT imaging during planning and using a surgical stent during the operation can significantly improve outcomes.[1] This article examines the conventional radiographic templates used in dental implant procedures, detailing their fabrication methods, advantages, and limitations. Additionally, it provides a comprehensive review of computer-aided surgical guides, highlighting their evolution and clinical applications.

2. Discussion

2.1. Surgical template

Surgical guides help prevent improper implant placement, minimize unnecessary bone removal, facilitate better

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prosthesis design, shorten surgical time, reduce trauma, and enhance patient comfort.[1] Poor implant positioning or angulation can complicate prosthetic rehabilitation, increase the risk of complications, and negatively affect the implant's long-term success. It may ultimately result in implant failure, subjecting the patient to further trauma, additional corrective procedures, and increased time and cost.

A surgical guide typically consists of a contact surface for support and a guiding cylinder that ensures precise positioning and orientation of the surgical drill.[2,3,6] Based on the type of support they rely on, surgical guides are categorized as mucosa-supported, bone-supported, or tooth-supported.[6-8] Bone- and tooth-supported guides generally provide greater stability than mucosa-supported ones, as soft tissues can lack the firmness and accuracy needed for precise guidance.[8] However, bone-supported guides may need fixation screws to prevent misalignment, due to their vulnerability to displacement.[9] In cases involving partially edentulous patients, a hybrid tooth- and bone-supported guide can offer enhanced accuracy while simplifying the surgical procedure. These guides can be designed to be either fully guided, managing both osteotomy and implant placement, or partially guided, where only the osteotomy is directed and implant placement is done manually.[7] Research shows that fully guided, tooth-supported static surgical guides significantly reduce angular deviations compared to partially guided systems used in combination with freehand implant placement.[7]

Surgical guides have evolved beyond their traditional role in dental implant placement to enhance precision and minimize complications across various dental and oral health procedures. These guides are particularly beneficial in surgeries involving the removal of unusual pathologies or foreign bodies located in hard-to-access areas. Their applications extend to procedures such as supernumerary tooth extraction, apicectomy, corticotomy, orthognathic surgery, and maxillary sinus lifts. By providing accurate guidance, surgical guides help ensure optimal outcomes and reduce the risk of postoperative complications in these complex procedures.

A surgical template is a guide used to assist in the accurate placement and angulation of dental implants. According to the Glossary of Prosthodontic Terms (GPT) 8, a surgical template is defined as a guide that aids in the correct surgical positioning and angulation of dental implants.[17]

The primary purpose of a surgical template is to guide the implant drilling system, ensuring precise implant placement in alignment with the planned surgical treatment. To effectively transfer the treatment plan to the surgical site, customized templates—whether traditional radiographic or computer-guided—have become the preferred approach.

A surgical guide comprises two key components: guiding cylinders and a contact surface. The contact surface is designed to fit securely against a specific part of the patient's anatomy—either the gums, jawbone, or teeth. The guiding cylinders play a crucial role in transferring the surgical plan by directing the drill to the precise position and angle.[18]

For optimal implant placement, several factors must be considered. First, the implant should be fully surrounded by bone or suitable bone graft material. Second, it's essential to avoid injury to nearby anatomical structures—such as the mandibular nerve in the lower jaw, the Schneiderian membrane in the upper jaw, and the roots of adjacent teeth. Third, the implant's placement must align properly with the planned prosthetic restoration.[19]

Surgical guides are generally categorized into three types: bone-supported, mucosa-supported, and tooth-supported.[18] To create guide holes and fabricate radiographic or surgical guides, three main techniques are commonly used: conventional freehand methods, milling, and computer-aided design/computer-assisted manufacturing (CAD/CAM) technology.[20]

2.2. Customized conventional radiographic surgical template

The radiographic template plays a crucial role in ensuring the success of implant placement, as it allows the predetermined prosthetic plan to be accurately transferred to the actual implant procedure.[18] When using a conventional radiographic method for the surgical template, a comprehensive radiographic examination and accurate assessment of the bone structure are essential.[21] Panoramic radiography remains the standard technique for implant planning. However, it has limitations, such as the inability to precisely measure bone dimensions, due to the inherent magnification factor, which is not always consistent. To improve the evaluation of bone structure in panoramic images, the magnification factor should be determined. (Mupparapu and Singer 2004).[19]

In traditional dental panoramic and plain film radiography, patients often wear a radiographic template embedded with radiopaque markers—such as metal spheres, rods, or guide posts—that correspond to the planned implant positions. These markers aid in assessing the implant site by considering the magnification factor and the known dimensions of the markers, allowing clinicians to estimate the implant's depth and size. The planning process for implant placement is influenced by several factors. The quality and quantity of the available bone are critical considerations, as they determine the stability and support for the implant. Additionally, the positioning of adjacent teeth must be taken into account to ensure that the implant aligns properly with the planned prosthetic restoration, achieving optimal aesthetics and phonetics.[19-23]

2.3. Fabrication process

The literature has documented several kinds of surgical guides, each intended for a certain implant process. While some guidelines are made for single implant placement, others are made for multiple implant placements, implant-retained overdentures, or fixed partial dentures (FPDs). Making diagnostic castings of the dental arches from irreversible hydrocolloid impressions is a popular method. In order to generate a mould for implant-supported FPDs, a silicone impression of the cast is made using the diagnostic wax-up of the proposed restoration. After that, the mould is filled with clear, chemically activated acrylic resin, which is allowed to cure. Access holes are created based on the information from the cast model, and stainless steel guide sleeves of uniform length are cut, placed in the access holes, and cured.[22,24,25]

A radiography guide can also be prepared using vacuum-formed templates. Once the final restoration's diagnostic wax-up is finished, a cast is poured and a replica is created. After covering the cast with the vacuum-formed template, a radiopaque substance, such as gutta percha, lead strip, or barium sulphate, is inserted into the edentulous space.[26,27]

Another alternative uses two vacuum-formed templates, one over the diagnostic wax-up duplicate cast and one over the blocked-out diagnostic cast. Both templates are then reattached to the original diagnostic cast using a clear plastic sheet. The templates' edges are precisely aligned by trimming them. After removing the diagnostic wax template, it is filled with radiopaque material or clear orthodontic resin and put over the cast that hasn't been altered. Drill guides are installed after holes are drilled using the radiograph as a guide for implant placement.

In order to determine the optimal implant angulations, radiopaque markers are utilised to identify critical structures, evaluate the markers' angulations in relation to the accessible bone, and predesign the implant placement direction.[26,27] These markers are frequently positioned in the middle of the teeth's occlusal surfaces, which line up with the prosthesis' screw access holes.[26]

A traditional dental surveyor is used to create parallel holes in the surgical guide using the very accurate milling process.[9,17,19] This method makes it possible to transform standard radiography guidance into accurate surgical guides. However, it calls for specific tools that are uncommon in private dental offices, and the operator needs to be skilled and experienced in order to operate the machine properly.[20]

2.4. Computer generated surgical template

Computer-generated surgical guides were created to overcome the drawbacks of traditional radiography surgical templates.[21] By precisely transferring the simulated plan to the surgical site, these guides act as a link between the treatment plan and the actual procedure. Stereolithography, a rapid prototyping technique that enables the creation of personalised surgical guides for every patient, is used to manufacture the surgical guide. With the use of stereolithography, surgical guides can be created from 3D computer-generated models, guaranteeing accurate implant placement.[26] The depth, angulation, mesiodistal, and labiolingual location of the implant are among the precise details preprogrammed into the guides created with this method.[26]

The patient's computed tomography (CT) scan is necessary for the production of stereolithographic templates. Multi-planar reformatting in CT imaging enables the creation of cross-sectional and panoramic views as well as the reorganisation of the volumetric dataset into sagittal, axial, and coronal cuts. Dental CT is the most precise and thorough imaging method for implant design because it creates 3D reconstructions of the dental arch and pertinent structures, like nerves, using techniques like volume rendering and shaded surface presentation. The placement, angle, depth, and diameter of virtual implants can be planned by practitioners using specialised software, and these are then superimposed onto the 3D data. Following the virtual planning, a CT scan using radiographic templates must be performed to review the diagnostic wax-up.[21,27,28]

CAD CAM is a rapid prototyping technique where, after generating a 3D treatment plan, the software slices the file and sends the information to a machine that fabricates the part layer by layer. There are two main methods of rapid prototyping:

1. Additive – widely used
2. Subtractive – less effective

The liquid photopolymer resin in a vat is the stereolithographic equipment (SLA). The template is created layer by layer, matching slice intervals, by a laser positioned above the vat that travels in successive 1 mm increments. Layers of photopolymerization take place: after the laser polymerises the resin surface layer, a mechanical table underneath the surface moves down 1 mm, enabling the laser to polymerise the subsequent layer on top of the first. Only 80% of the polymerisation in SLA takes place in the vat; the remaining 20% is finished in a traditional UV light curing machine.[12]

The resulting surgical template is equipped with surgical-grade stainless steel tubes with sleeves, 5 mm in height and 0.2 mm wider than the osteotomy, to limit angulation deviations to 5°. A buccal window is created to enhance retention during surgery. Typically, three 2 mm holes are placed on the buccal surface of each side of the denture.[4]

2.5. Advantages

1. Accurate implant placement

2. Preservation of surrounding anatomical structures
3. 3D technology enables precise assessment of anatomical points, such as the size of the maxillary sinus in the upper jaw and the position of the alveolar nerve in the lower jaw
4. Detailed analysis of bone topography
5. Provides essential data on implant size, direction, and bone location for precise positioning
6. High accuracy rate, with precision up to 0.1 mm
7. Reduced surgical time
8. Minimally invasive, flapless surgery, leading to less swelling
9. Less postoperative discomfort for both the dentist and patient
10. Clear material allows for visibility through the model
11. Overview of the stereolithography fabrication process
12. A CT scan is performed with a radiographic template in place, which includes radiopaque markers.

2.6. Disadvantages

1. Limited visibility and lack of tactile feedback during the surgery
2. Inadequate mouth opening may hinder the surgical process
3. Potential risk of injury to critical anatomical structures

3. Conclusion

Growing needs for prosthetics and improvements in surgical reconstructive techniques require extremely accurate implant placement, planning, and diagnosis. In order to achieve the best prosthetic results, the doctor can put implants in locations where the bone-implant interaction is maximised by determining the bony anatomy in respect to the teeth prior to surgery. Many clinicians still favour the conventional technique for its proven reliability and cost-effectiveness, even though the computer-generated stent is thought to be a better strategy. To help with precise planning and direction throughout the surgical phase, many practitioners also utilise cross-sectional imaging-based surgical guide templates. When exact implant placement is needed, computer-aided planning and image-guided surgery are very helpful because they guarantee a safe location that makes the best use of the available bone. These techniques can be very helpful when a CT scan is recommended as a part of the diagnostic procedure. To properly evaluate the effect of the wholly limited design on treatment outcomes in oral implantology, more evidence-based research is necessary.

4. Conflict of Interest

None.

5. Source of Funding

None.

References

1. Talwar N, Singh BP, Chand P, Pal US. Use of Diagnostic and Surgical Stent: A Simplified Approach for Implant Placement. *J Indian Prosthodont Soc*. 2010;10(4):234–9.
2. Ramasamy M, Raja R, Narendrakumar R. Implant surgical guides: From the past to the present. *J Pharm Bioallied Sci*. 2013;5(Suppl. S1):S98–102.
3. Widmann, G.; Bale, R.J. Accuracy in computer-aided implant surgery—A review. *Int J Oral Maxillofac Implants*. 2006;21(2):305–13.
4. Jun Kuo, Chih-Cheng Hung. An assistant guide for accurate placement of dental implants; Becker CM, Kaiser DA. Surgical guide for dental implant placement. *J Prosthet Dent*. 2000;83(2):248–51.
5. Ku YC, Shen YF. Fabrication of a radiographic and surgical stent for implants with a vacuum former. *J Prosthet Dent*. 2000;83(2):252–3.
6. Raico Gallardo YN, da Silva-Olivio IRT, Mukai E, Morimoto S, Sesma N, Cordaro L. Accuracy comparison of guided surgery for dental implants according to the tissue of support: A systematic review and meta-analysis. *Clin Oral Implants Res*. 2017;28(5)602–12.
7. Floriani F, Jurado CA, Cabrera AJ, Duarte W, Porto TS, Afrashtehfar KI. Depth distortion and angular deviation of a fully guided tooth-supported static surgical guide in a partially edentulous patient: A systematic review and meta-analysis. *J Prosthodont*. 2024;33(Suppl. S1):10–24.
8. Shi Y, Wang J, Ma C, Shen J, Dong X, Lin D. A systematic review of the accuracy of digital surgical guides for dental implantation. *Int J Implant Dent*. 2023;9(1):38.
9. Mandelaris GA, Rosenfeld AL. Alternative applications of guided surgery: Precise outlining of the lateral window in antral sinus bone grafting. *J Oral Maxillofac Surg*. 2009;67(11 Suppl):23–30.
10. Goodacre BJ, Swamidass RS, Lozada J, Al-Ardah A, Sahl E. A 3D-printed guide for lateral approach sinus grafting: A dental technique. *J Prosthet Dent*. 2018;119(6):897–901.
11. Jeong M, Kwon DH, Lee SJ. Computer guided root tip extraction and implant placement: A clinical report. *J Prosthet Dent*. 2024:S0022-3913(23)00832-6.
12. Mao MY, Wang CZ, Zhu HH, Fan MX, Wu XF, Zhu FD. Design and validation of a surgical guide for the retrieval of foreign body instruments in jaw. *Acta Anat Sin*. 2023;54:244.
13. Brunso J, Franco M, Constantinescu T, Barbier L, Santamaría JA, Alvarez J. Custom-machined miniplates and bonesupported guides for orthognathic surgery: A new surgical procedure. *J Oral Maxillofac. Surg*. 2016;74(5):1061.e1–e12
14. Cassetta M, Giansanti M, Di Mambro A, Calasso S, Barbato E. Minimally invasive corticotomy in orthodontics using a three-dimensional printed CAD/CAM surgical guide. *Int J Oral Maxillofac Surg*. 2016;45(9):1059–64.
15. Lee H, Chae YK, Choi S, Jih MK, Lee JW, Choi SC, et al. Feasibility of a 3D surgical guide technique for impacted supernumerary tooth extraction: A pilot study with 3D printed simulation models. *Appl Sci*. 2019;9(18):3905.
16. Peng L, Wang ZH, Sun YC, Qu W, Han Y, Liang YH. Computer aided design and three-dimensional printing for apicoectomy guide template. *J Peking Univ Health Sci*. 2018;50(5):905–10.
17. The glossary of prosthodontic terms. *J Prosthet Dent*. 2005;94(1):10–92.
18. Drill guides for every case scenario: SurgiGuide Cookbook. Available from: http://www.materialisedental.com/materialise/view/en/2395185SurgiGuide+dental+drill+guide+Cookbook.html.
19. Brief J, Edinger D, Hassfeld S, Eggers G. Accuracy of image-guided implantology. *Clin Oral Implants Res*. 2005;16(4):495–501.
20. Arfai NK, Kiat-Amnuay S. Radiographic and surgical guide for placement of multiple implants. *J Prosthet Dent*. 2007;97(5):310–2.
21. Widmann G, Bale RJ. Accuracy in computer-aided implant surgery: A review. *Int J Oral Maxillofac Implants*. 2006;21(2):305–13.

22. Meitner SW, Tallents RH. Surgical templates for prosthetically guided implant placement. *J Prosthet Dent*. 2004;92(6):569–74.
23. Marchack CB, Moy PK. The use of a custom template for immediate loading with the definitive prosthesis: A clinical report. *J Calif Dent Assoc*. 2003;31(12):925–9.
24. Takeshita F, Suetsugu T. Accurate presurgical determination for implant placement by using computerized tomography scan. *J Prosthet Dent*. 1996;76(6):590–1.
25. Solow RA. Simplified radiographic-surgical template for placement of multiple, parallel implants. *J Prosthet Dent*. 2001;85(1):26–9.
26. Lal K, White GS, Morea DN, Wright RF. Use of stereolithographic templates for surgical and prosthodontic implant planning and placement. Part I. The concept. *J Prosthodont*. 2006;15(1):51–8.
27. Schwarz MS, Rothman SL, Rhodes ML, Chafetz N. Computed tomography: Part I. Preoperative assessment of the mandible for endosseous implant surgery. *Int J Oral Maxillofac Implants*. 1987;2(3):137–41.
28. Schwarz MS, Rothman SL, Rhodes ML, Chafetz N. Computed tomography: Part II. Preoperative assessment of the maxilla for endosseous implant surgery. *Int J Oral Maxillofac Implants* 1987;2(3):143–8.

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