International Journal Of

Recent Scientific Research

ISSN: 0976-3031

Volume: 7(4) April -2016

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THE OFFICIAL PUBLICATION OF
INTERNATIONAL JOURNAL OF RECENT SCIENTIFIC RESEARCH (IJRSR)
http://www.recentscientific.com/ recentscientific@gmail.com

ISSN: 0976-3031

Available Online at http://www.recentscientific.com

International Journal of Recent Scientific Research
Vol. 7, Issue, 4, pp. 9999-10003, April, 2016

International Journal of Recent Scientific Research

Review Article

SYSTEMATIC ANALYSIS ON EFFICACY OF SURGICAL TEMPLATES IN IMPLANT DENTISTRY

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ARTICLE INFO

Article History:

Received 05th January, 2015
Received in revised form 08th February, 2016
Accepted 10th March, 2016
Published online 28st April, 2016

Keywords:

Guided dental implant surgery, Guided dental implant placement, cast based guided dental implant placement, computer Guided dental implant surgery, surgical templates in dental implants, Dental implants placement using CBCT,CT guided implant placement , Dental implants placement by CAD CAM .

ABSTRACT

Aims & Objectives: This review aims at analysing the efficacy of surgical templates in implant dentistry.
Methods & Materials: The following databases were searched for studies comparing different shade matching methods. MEDLINE (pubmed), Embase, and Google scholar. Reference lists of articles were also searched.
Results: This systematic review evaluated 22 studies that comparing the efficacy of surgical templates in implant dentistry. Successful final treatment outcome is achieved clinically with the help of a computer aided surgical guide. But compared to the conventional technique, limitation with computer-aided implant surgery requires substantially greater investment and effort.
Conclusion: This systematic review reveals The Three-dimensional guided implant surgery improves the quality of both the surgical procedure and the restorative results, enabling a very safe and predictable rehabilitation compared with conventional surgery.

INTRODUCTION

Dental implants have become a treatment options widely used for the replacement of lost teeth. The development of dental implants has had a major impact on the patients and the implant supported oral restoration has become an increasingly used treatment option for partially edentulous and completely edentulous patients, also even in patients with severe bone loss and in locations which all previously considered unsuitable for implant placement has been made possible by means of bone augmentation, regeneration and soft tissue regeneration procedures.[1] The success of dental implants in the treatment of patients is directly related to patient evaluation and good treatment planning.

Earlier dentists were intended to place implants where the greatest amount of bone was present, with less regard to placement of final definitive restoration. In most of the times, the placement of implant was not as accurate as intended. Even a minor variation in comparison to ideal placement causes difficulties in fabrication of final prostheses.[1] Failures arise as a result of lack of consideration of the super structure during pre-surgical planning. Accurate placement is required to achieve best functional and aesthetic result. Since the oral cavity is a relatively restricted space, a high degree of accuracy in placement of implant is very important for success of the prostheses. This can be achieved by means of a surgical guide, which provides adequate information regarding implant placement and at the time of surgery it fits on to the existing dentition or on to the edentulous span.

Recent studies on the clinical success of dental implants have indicated a high implant survival rate. Nevertheless, the inadvertent association of most surgical and prosthetic complications with improper diagnosis and implant placement has also been documented. These factors play a crucial role in the long-term predictability and success of implant prosthetics. Surgical guide templates not only assist in diagnosis and treatment planning but also facilitate proper positioning and angulation of the implants in the bone. Moreover, restoration

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driven implant placement accomplished with a surgical guide template can decrease clinical and laboratory complications. Hence, increasing demand for dental implants has resulted in the development of newer and advanced techniques for the fabrication of these templates[2]. This review compares unaided and aided implant placements.

Table 1 Search strategy

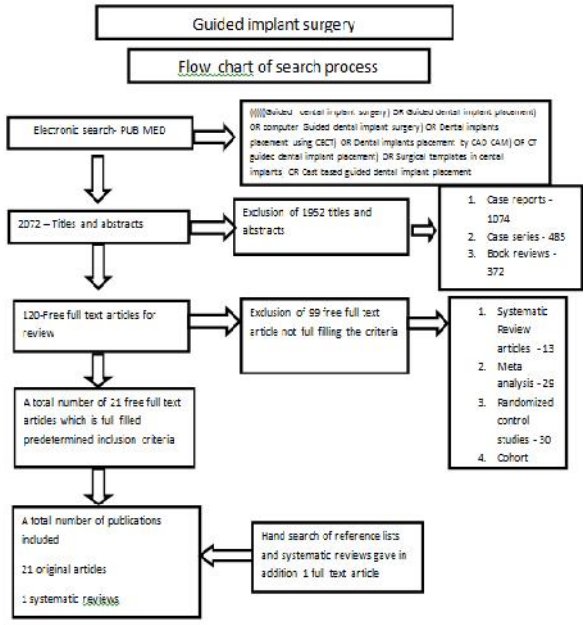
Database	Search No.	Search term	Results
Medline (Pubmed)	1.	Guided dental implant surgery	1767
	2.	Guided dental implant placement	755
	3.	computer Guided dental implant surgery	301
	4.	Dental implants placement using CBCT	124
	5.	Dental implants placement by CAD CAM	176
	6.	CT guided dental implant placement	67
	7.	Surgical templates in dental implants	127
	8.	Cast based guided dental implant placement	6
	9.	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8	2072
Google Scholar	1.	Guided dental implant surgery or guided dental implant placement and prosthodontics	9050

Table 2 Inclusion and exclusion criteria

Parameters	Inclusion criteria	Exclusion criteria
Study design	1. Systematic Review articles 2. Meta analysis 3. Randomized control studies 4. Cohort studies 5. Case Control studies	1. Case reports. 2. Case series. 3. Letter to Editor. 4. Book reviews. 5. Professional communications. 6. Systemic reviews. 7. Animal studies.
Publication date	From last ten years to april 30, 2015	Unpublished or ongoing trials, published before ten years
Language	English	Non-English
Conflict of interest	Free of conflicts of interest	Comparing specific brands of instruments

Table 3 Selection process

Assessment	Exclusion criteria
Titles	Irrelevant topics
Abstract	Irrelevant study type(case report)
Full text	No applicable data, Non English



MATERIALS AND METHODS

This topic is reviewed systematically as follows

DISCUSSION

Several types of surgical guides have been reported in the literature. Some are designed for placement of a single implant, while other reports present designs for implant fixed partial dentures, multiple single implants, and implant-retained over dentures. Some of the most commonly used techniques are mentioned briefly here.

Diagnostic casts of the dental arches are made from irreversible hydrocolloid impressions. A diagnostic wax up of the proposed in case of an implant supported FPD is done. A silicone impression of the cast with the waxed FPD is made as a mold. A clear, chemically activated acrylic resin is poured into the mold space and cured. Access holes are made according to information obtained from the cast model for initial surgical drill. Stainless steel guide sleeves of uniform length is cut and placed in access holes and cured[1]

Yet another method to prepare a radiographic guide is from vacuum formed templates. After the diagnostic wax up of the final restoration is completed, duplication is made and a cast is poured. The vacuum formed template fabricated is placed over the cast and the edentulous space is filled with radio opaque material (Barium sulphate, lead strip, gutta percha).[6]

In another method, it make use of two vacuum formed templates, one over the blocked out diagnostic cast and other over the duplicate cast of the diagnostic wax up with a clear plastic sheet is made.[13] Both the templates are returned to the unaltered diagnostic cast. The edges of the two templates are trimmed to make them coincident. The diagnostic wax template is removed and filled with clear orthodontic resin or radio opaque material. The filled template is placed over the template of the unaltered diagnostic cast,[18] Holes are made according to information obtained from the radiograph for placement of implants, followed by placement of drill guides.[19,20]

The radiopaque markers helps in predesigning the direction of implant placement and in comparing the angulations of radiopaque markers with the available bone and also in locating the position of the vital structures to determine the best angulations for the implant, These radio-opaque markers can be placed in the center of the occlusal surfaces of the teeth that corresponds to the screw access holes of the prosthesis.[9]

The milling technique is an accurate technique in which it employs parallel holes in the surgical guide. This technique needs the aid of a conventional dental surveyor. All the conventional made radiographic guides can be converted to an accurate surgical guide by means of this milling technique. Limitation in this technique is, it requires special equipment not commonly available in private dental practices. In addition, the practitioner needs a certain amount of experience and knowledge to use this machine properly.[1]

Assessment of the articles:			
Author	**Types of templates**	**No of implants placed**	**Results- [predictability/accuracy/success/ease of use/ease of fabrication/patients satisfactory/invasiveness]**
1.Manikandan Ramasamy *et al*.,	1.Bone supported, 2.Mucosa supported, and 3.Tooth supported.	review	High accuracy in planning and execution of surgical procedures is important in securing a high success rate without causing iatrogenic damage. This can be achieved by computed tomography, 3D implant planning software, image-guided template production techniques, and computer-aided surgery
2.Kathleen Manuela D'Souza *et al*,	1. Non-limiting design 2. Partially limiting design 3. Completely limiting design	review	it has been observed that most clinicians use surgical guide templates that are based on cross-sectional imaging to facilitate accurate planning and guidance during the surgical phase.
3.Mohammed Zaheer Kola *et al*.,	Computer-aided design/computer-assisted manufacturing-based surgical guide	review	Computer-aided planning and image-guided surgery can be carried out, when implant positioning is to be precisely executed, and when safe positioning of implants with optimal use of available bone, and whenever a CT scan is recommended as a diagnostic means evidence-based research still needs to be conducted
4.Jee-Ho Lee *et al*.,	Stereolithographic implant template.	102 implants in 48 patients	The mean errors of computer-assisted implant surgery were 1.09 mm at the coronal center, 1.56 mm at the apical center, and the axis deviation was 3.80°. The coronal and apical errors of the implants were found to be strongly correlated.
5.S.m. meloni *et al*.,	Radiographic template	72 implants	All patients reached 24 months follow-up, and no patients dropped out from the study. The cumulative survival rate was 100%; after 24 months mean marginal bone remodelling value was: 1.35 ± 0.25, mean PPD value was 2.75 ± 0.40 mm and mean BOP value was 3.8% ± 1.8%. Only minor prosthetic complications were recorded**.**
6. Michael Patras *et al*	Vacuform template	6 implants	This template design in such staged procedures provided stability in the surgical field and enhanced the accuracy in implant positioning based upon the planned restoration, thus ensuring predictable treatment outcomes.
7. Margareta Hultin *et al*.,		Review of 4032 implants	A total of 852 patients were treated with 4032 implants using computer-guided implant surgery. The number of patients included in each study ranged from 6 to 206. The age ranged from 16 to 92 years and the follow-up period varied between 1 and 49 months.
8.Christopher B. Marchack *et al*,.	Radiographic and surgical template	2 implants	A new technique using a dual CT scan and surgical planning software to produce a CAD/CAM surgical template that transfers the position of the planned implants to the patient is described. The advantages of this procedure, for the completely edentulous arch, include (1) shorter surgery times, (2) shorter treatment times, (3) less invasive, flapless surgery and, therefore, less chance of swelling, less pain, and faster initial healing times, (4) placement of a prefabricated definitive or provisional prosthesis, and (5) use ofthe fixed prosthesis immediately
9. Anna M. Sanna *et al*.,	Radiolucent scan template made of heat-polymerized acrylic resin	212 implants	Nine (4.9%) implants failed. Eight of the failures occurred in 3 smoking patients. The absolute survival rate for all patients was 95%, while the cumulative survival rate (CSR) after 5 years was 91.5%. For the NS group, the CSR was 98.9%, while for the S it was 81.2%. The mean marginal bone resorption was - 2.6 and - 1.2 mm in the S and NS groups, respectively.
10. Chanseop Park *et al*.,	Clear vacuum-formed matrices, with or without the use of autopolymerized acrylic resin, and gutta-percha or metal rods	120 implants	Two-way ANOVA demonstrated that guide height did not significantly affect the accuracy of the implant position. The distance from the reference point to the point of measurement was significantly smaller for placement through the guide compared to freehand placement at both implant (P<.001) and abutment levels (P<.001). The angular discrepancy was also significantly smaller for placement through the guide (P<.001).
11. Saad A. Al-Harbi *et al*.,	The radiographic guide can be converted to a surgical template or a stereolitho-graphic template	6 implants	Conventionally made surgical templates may lack stabilityinthissituationandmaybelesspredictable.The surgical template described permitted the use of staged tooth extraction to facilitate immediate implant placement in a patient with a nonrestorable dentition.
12.Richard J. Windhorn*et al*.,	autopolymerized acrylic resin with wooden stick	1 implant	It is a time-efficient procedure and can be fabricated from materials readily available in most dental office laboratories.
13. Kazuho Yamada *et al*.,	Clear vacuum-formed matrices, with with metal sleeves	6 implants	The superstructure described in this article can solve the problems related to misfit of preoperatively fabricated restorations for immediate implant loading.
14. Naina Talwar *et al*.,	autopolymerizing acrylic resin	2 implants	For a successful implant supported definitive restoration the implant must be placed at a correct and pre-planned position and angulation. The mesiodistal placement of the implant should aid in preservation of papilla and provide an esthetic implant restoration profile.
15. José L. Cebrian-Carretero *et al*.,	Radiologic splint acrylic resin	6 implants	The initial osseointegration was of the 100% and after 18 months of function, no implants have failed. During this period the peri-implant bone loss was less than 1 mm and all the implants could be rehabilitated. Planning and placement were precise with a margin of error of less than 1 mm, between virtual surgery and the final position in the patient

16. Minkle Gulati *et al*		review	As a result, attempts are now been made toward complete automation of implant-dentistry. Yet, keeping the limitation of high radiation dose, computerized implant-dentistry must be limited to anatomically complicated cases. Future tasks include advanced intraoperative imaging techniques for navigated surgeries along with sophisticated mechanized surgical tools and new robotic developments, which will revolutionize the field of implantology.
17. Mario Beretta *et al*.,	Rapid prototyping technique template	14 implants	The comparison of 14 implants showed a mean linear deviation of the implant head of 0.56 mm (standard deviation [SD], 0.23), a mean linear deviation of the implant apex of 0.64 mm (SD, 0.29), and a mean angular deviation of the long axis of 2.42° (SD, 1.02).
18. María Peñarrocha *et al*.,	Clear acrylic resins	19 implants	Flapless surgery offers a number of advantages, including a better postoperative course for the patient, and a shortening of the surgical times. These aspects have been documented by a series of metaanalyses.
19. G. De vico *et al*.,	Clear acrylic resins	2 implants	Three-dimensional guided implant surgery improves the quality of both the surgical procedure and the restorative results, enabling a very safe and predictable rehabilitation compared with conventional surgery.
20. FC Ng *et al*.,	Clear acrylic resin	7 implants	With navigational technology, implant surgery need not be "blind". With real-time direct virtual vision, both surgeons and patients are reassured of surgical safety. This increases the confidence and reduces surgical stress in both the patient and the clinician.
21. Silvio Mario Meloni *et al*.,	autopolymerizing acrylic resin	60 implants	Radiological estimation showed a mean peri-implant marginal bone loss of 1.4 ± 0.3 mm.
22. Evdokia Chasioti *et al*,.	Temporaru acrylic material	8 implants	3 types of surgical guides results in angular deviation of 4.1° ± 2.3° and linear deviation of 1.1 ± 0.7 mm at the implant neck and 1.41 ± 0.9 mm at the implant apex away from the proposed implant site.
23. Young-June Huh *et al.*	Resin template	2 implants	The discrepancy of the insertion point P (x, y) ranged from 0.12 mm to 0.93 mm on the X-axis and from 0.21 mm to 0.91 mm on the Y-axis. The discrepancy of insertion angulations to the XOY-plane (Xθ, Yθ) ranged from 0.35 to 0.89 on the X-axis and from 0.45 to 0.77 on the Y-axis. The mean values of ΔX, ΔY, ΔXθ, and ΔYθ were 0.46mm, 0.57 mm, 0.64°, and 0.57°, respectively.
24.Gianni Frisardi *et al*.,	Clear acrylic resins	---	Radiological guide (*mean value* -0.009 mm, *SD* 0.069 mm) and the surgical guide or Duplicate Radiographic Template (*mean value* 0.013 mm, *SD* 0.141 mm) are reported. Moreover, the fitting of the radiological guide model, obtained by processing DICOM images on the gypsum cast has been verified (*mean value* -0.004 mm, *SD* 0.082 mm).
25. Shin-Young Youk *et al*,	Survey	----	Among the patients who have undergone computer-guided implant surgery, those who also had prior experience of surgery without a computer-guided template expressed higher satisfaction with the former (*P*<.05).
26. Elnaz Moslehifard *et al*.,	autopolymerized methyl–metacrylate resin mixture	----	Consequently, the modification of stent for the surgical procedures is accomplished. This technique is more convenient, economical, and less traumatic for the patient. It can be used with any implant system and only minimal materials and components are required.
27. Fotios Tzerbos *et al*.,	Heat cure acrylic/ clear acrylic resins	6 implants	The clinical report describes the diagnostic arrangement of teeth, the ridge augmentation based on the diagnostic evaluation of the removable prosthesis, the implant placement with a surgical guide in the form of the removable partial denture duplicate and finally the special 2-piece design of the final fixed prosthesis.

CONCLUSION

This systematic review reveals The Three-dimensional guided implant surgery improves the quality of both the surgical procedure and the restorative results, enabling a very safe and predictable rehabilitation compared with conventional surgery. With significant achievements accomplished in the field of computerized implant-dentistry implant placement has become highly predictable, even in patients where implant surgery was contra-indicated formerly. Finally the digital planning allowing an ideal implant position (depth and mesio-distal distance between natural teeth or other implants), guarantees the best esthetic results in all clinical situations.

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TSSN 0976-3031