MedNEXT
Journal of Medical an Health Sciences

REVIEW ARTICLE

# Minimally traumatic implantation and bone regeneration: a systematic review

**Orley Alvarez[1,4,5]*, Steven López[2,4,5], Carlos Alberto Sánchez[3,4,5], Elias Naim Kassis[4,5]**

[1] Centro Odontologico Odan Dental, Edificio City Office piso 9 oficina 933, Av Benjamín Carrión Mora & Dr Emilio Romero Menéndez, Guayaquil - Ecuador.
[2] Clínica Dental STY. Av. 9 de Octubre y Av. Ignacio de Veintimilla. Torre B sexto piso Quito – Ecuador.
[3] Clínica Integral y Estética. Av. Diego de Vázquez N64-85 y calle San Carlos. Cotocollao. Quito – Ecuador.
[4] UNORP - University Center North Paulista - Sao Jose do Rio Preto, Sao Paulo, Brazil.
[5] UNIPOS - Post graduate and continuing education, Sao Jose do Rio Preto, Sao Paulo, Brazil.

*Corresponding author: Orley Alvarez, Unorp/Unipos - Post graduate and continuing education, Sao Jose do Rio Preto, Sao Paulo, Brazil.
Email: alvarez_orley@hotmail.com
DOI: https://doi.org/10.54448/mdnt22S101
Received: 10-13-2021; Revised: 12-10-2021; Accepted: 12-17-2021; Published: 03-28-2022; MedNEXT-id: e22S101

## Abstract

**Introduction:** Dental implant procedures have reached about one million dental implants per year worldwide. In this context, it is necessary to establish the state of the art of minimally traumatic procedures for dental implants, especially after bone grafting procedures and/or use of biomaterials for bone elevation. **Objective:** Conducted a systematic review of the main considerations for optimizing techniques for dental implants by proposing minimally invasive procedures, especially after bone recovery or elevation processes through the use of biomaterials such as FRP and Bio-Oss®. **Methods:** The survey was conducted from June 2021 to July 2021 and developed based on Scopus, PubMed, Science Direct, Scielo and Google Scholar, following the rules of Systematic Review-PRISMA. Study quality was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** Studies have shown that guided preoperative planning and dental implant-guided jaw reconstruction provide high success rates for implant and dental rehabilitation. Furthermore, the concept of using personalized implants with the help of 3D virtual treatment planning can greatly improve mandibular restoration and help to achieve good facial profile, esthetics and dental rehabilitation, avoiding complications with grafts in general.

**Keywords:** Implantology. Implants. Minimally traumatic surgery. Bone regeneration. Biomaterials.

## Introduction

Dental implant procedures have reached about one million dental implants per year worldwide [1]. In this scenario, maxillary atrophy is a frequent clinical condition and the cause that lead to focal or generalized atrophy [1-3]. Bone density influences the operative protocol and the choice of the type of implant used to replace lost teeth [4]. In this context, it is necessary to establish the state of the art of minimally traumatic procedures for dental implants, especially after bone grafting procedures and/or the use of biomaterials for bone elevation.

In the scenario of bone loss, the loss of a dental element in the posterior region of the maxilla can lead to natural resorption of the alveolar process and pneumatization of the maxillary sinus [5,6]. This can increase the volume in the root direction, making it difficult to restore implants in place [7]. Thus, the floor of the maxillary sinus should be elevated or short implants used when possible. Furthermore, the autogenous bone graft is the only one capable of presenting the three processes such as osteogenesis, osteoinduction, and osteoconduction, ensuring a self-regenerative potential [7]. As a disadvantage to autogenous bone graft, the need for second surgical access in the donor area is highlighted, resulting in longer surgical time. In this sense, with the objective of increasing the bone formation potential of grafts, combinations have been proposed to obtain better regenerative conditions through volume preservation and induction of cell migration differentiation [8-12].

Thus, in the last 20 years, platelet concentrates such as platelet-rich plasma (PRP) and fibrin-rich plasma FRP have been proposed as regenerative materials in tissue regeneration procedures, which act

DOI: 10.54448/mdnt22S101

with osteoinductive properties. These have been indicated for use in combination with other biomaterials [8,11]. As an example of a combination of PRP or FRP, Bio-Oss® stands out, being a bovine bone biomaterial. The excellent osteoconductive properties of Bio-Oss® lead to predictable and efficient bone regeneration [10-13].

In this context of optimizing techniques for better management of dental implants, faster and more accurate methods were developed by dentists, with post-operatives with better results and quality of life, through minimally invasive procedures with the development of numerous software and hardware (equipment and instruments) for performing computer-guided (CG) surgeries [14]. In this sense, it is essential to perform Computed Tomography (CT) on the patient, with reference points, such as the prosthesis itself, to capture images on a computer, with images processed in the programs as an example [15].

This software allows the placement of implants in the program, as well as the creation of a high-precision surgical guide, leading to the possibility of performing flapless surgeries, for the placement of implants and prosthesis in immediate load on patients [16]. The accuracy of Guided Surgery systems for the placement of dental implants depends on a number of interacting factors [17]. In this sense, as information gaps, we can mention the image acquisition process, the registration process, the software navigation, the production of the surgical guide, and human error [18-20].

Although the placement of the implant with the aid of the computer requires greater investment and effort, it seems to provide a good result, in the sense of eliminating errors and systematizing the successful reproduction of treatments [21]. Added to this, CG allows the protection of critical anatomical structures, as well as aesthetic and functional advantages that come from placing the implant in the location determined by the prosthesis. CG is not indicated in easy cases, with sufficient anatomical guidance and bone volume [22], but it helps in cases where CT is recommended as a diagnostic tool, when precise placement of the implant is necessary, and when implants with longer lengths are for the optimal use of available bone [23]. Furthermore, this made it necessary to include the use of guided surgical planning and computer-aided design and manufacturing (CAD-CAM), and three-dimensional printing [24].

Therefore, this study carried out a systematic review of the main considerations for optimizing techniques for dental implants by proposing minimally invasive procedures, especially after bone recovery or elevation processes through the use of biomaterials such as FRP and Bio-Oss®.

## Methods

### Study Design

The rules of the Systematic Review Platform-PRISMA (Transparent report of systematic reviews and meta-analysis-HTTP: //www.prisma-statement.org/) were followed [25].

### Data sources and research strategy

The search strategies for this systematic review were based on the keywords (MeSH Terms): "Implantology. Implants. Minimally traumatic surgery. Bone regeneration. Biomaterials". The survey was conducted from May 2021 to June 2021 and was developed based on Scopus, PubMed, Science Direct, Scielo, and Google Scholar. In addition, a combination of the keywords with the Boolean "OR", "AND" and the "NOT" operator were used to target the scientific articles of interest.

### Study Quality and Risk of Bias

The quality of the studies was based on the GRADE instrument [26] and the risk of bias was analyzed according to the Cochrane instrument [27].

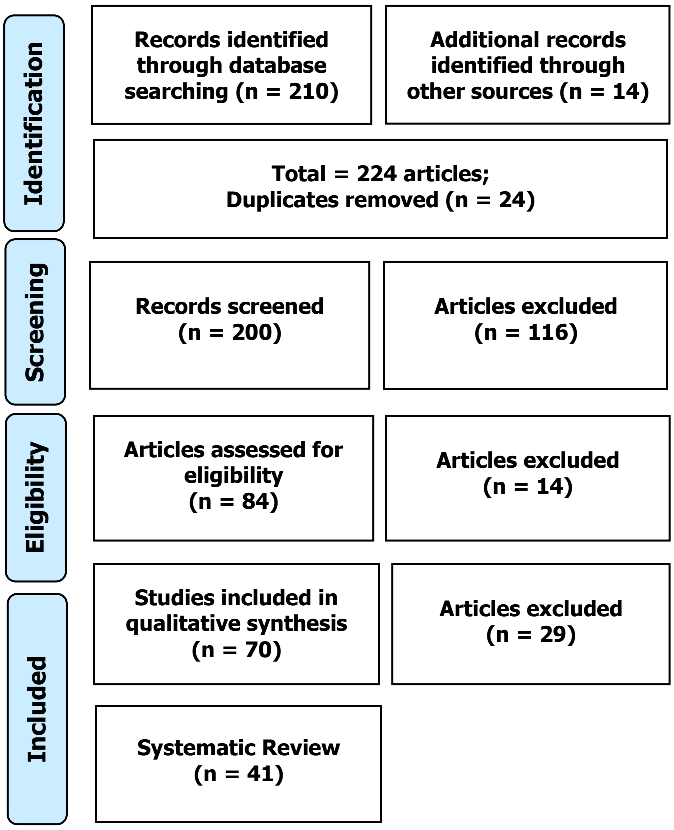
## Results and Discussion

A total of 224 articles were found in the. Initially, duplication of articles was excluded. After this process, the abstracts were evaluated and a new exclusion was performed, removing the articles that did not address the theme of this article. In total, 70 articles were fully evaluated and 41 were included and evaluated in this study (**Figure 1**).

Considering the Cochrane tool for risk of bias, the overall assessment in 4 studies with a high risk of bias and 2 studies with uncertain risk. The domains that presented the highest risk of bias were related to the number of participants in each study addressed, and the uncertain risk was related to the safety and efficacy of minimally traumatic procedures with the use of guided surgery for dental implants, especially after bone regeneration induced by biomaterials. In addition, there was no funding source in 3 studies and 2 studies did not disclose information about the declaration of conflict of interest.

After a complete analysis of the studies, it was found that important care in the implant dentistry process is very important, given that the lack of bone in the alveolar crests has been a major problem in the functional esthetic recovery in patients with dentoalveolar trauma [28], extractions dental, periodontal disease, congenital tooth absence, maxillary and mandibular pathologies, in addition to infections due to the emotional and the possibility of deformities due to the lack of protein load [1-3].

**Figure 1.** Eligibility of the articles.




In this context, FRP presents leukocytes, platelets, and growth factors, forming a fibrin matrix, with a three-dimensional architecture. It is the second generation of platelet concentrate with a high potential for wound repair. It is based on the protection of growth factors from proteolysis that can maintain their activity for a longer period and stimulate bone regeneration more efficiently [29-31].

In this regard, the development of optimized implant surfaces is a matter of great research with the aim of accelerating the osseointegration process, leading to a reduction in the waiting time before loading, in addition to making the immediate loading of the implant safer [32]. It was documented for the first time that the combination of biomaterial and FRP significantly improved bone regeneration in the peri-implant area. The placement of the implant with the simultaneous use of the PRP creates a good relationship between the hard tissue and the soft tissue, in addition to the advantage of the psychological relationship with the patient [33].

Also in this context, the Bio-Oss® biomaterial is one of the most used in guided bone regeneration procedures in regenerative dentistry. The excellent osteoconductive properties of Bio-Oss® lead to predictable and efficient bone regeneration, Bio-Oss® particles become an integral part of the newly formed bone structure and conserve their volume in the long term [13]. Furthermore, Bio-Oss® offers a lot of space for the formation of blood vessels (angiogenesis) and the deposit of neoformed bone [34], helping to grow osteoblasts [33,35].

Based on this, notable studies have shown results on the combined use of Bio-Oss® and FRP. One study investigated clinically and histologically the potential of FRP as a graft material in pre-implant reconstructive surgeries for severe maxillary atrophy after sinus lift procedures in 106-120-180 days, to determine whether the use of FRP is capable of accelerating the bone regeneration process in order to promote implant stability. The control group was used only Bio-Oss®. As a result, the use of FRP optimized bone formation [12].

Another study compared the use of Bio-Oss® with FRP and Bio-Oss® with Tisseel® to improve bone regeneration. After elevating the sinus membrane in both maxillary sinus cavities, an implant was placed in the sinus cavity. The FRP/Bio-Oss® composite was grafted and the Tisseel® / Bio-Oss® composite was grafted into the other sinus cavity. After 6 months, the mean rate of osseointegration was 43.5 ± 12.4% and the rate of new bone formation was 41.8 ± 5.9% at the FRP/Bio-Oss® composite sites. In the composite sites, Tisseel® / Bio-Oss® was 30.7 ± 7.9% and 31.3 ± 6.4%. The findings of this study suggested that with FRP together with Bio-Oss® particles, bone formation at the graft sites is significantly greater than when Tisseel® is used [13].

Thus, the optimized processes of implantology and biomaterials allow the installation of implants in areas of thin bone thickness, width, and height, with simpler surgeries and greater success rate and patient comfort [1]. The lack of bone in the alveolar crests has been a major problem in functional aesthetic recovery in patients who have suffered dentoalveolar trauma, traumatic tooth extractions, congenital tooth loss, maxillary and mandibular pathologies [1]. In this sense, the bioactivation of the dental implant surface with FRP has been described and discussed by the scientific community as a surface treatment for the stimulation and acceleration of the osseointegration process, as well as to achieve greater implant stability [32].

In this scenario, CG in dentistry and advances in technology have contributed to the improvement of models, as there was only the direct molding technique to obtain patient models, with implant placement not very favorable in aesthetic terms [1]. The information that is acquired in the 3D reconstructions allows to determine the quantity and quality of available bone and also enables the simulation of implant installation in a virtual environment [1,15]. Also, the use of CT and program developments for guided planning are orienting oral surgery precisely towards a specific target. Thus, the planning of virtual dental implants allows for a prosthetic approach, resulting in the best possible design of the prosthesis, better esthetics, optimized occlusion, and loading [36].

This approach also changed the surgical paradigm of using large flaps to obtain an adequate view of the surgical area, as flapless implant surgery, with or without immediate loading, became more predictable [37]. In this sense, CG refers to the use of a tissue-supported surgical model. This reproduces the virtual implant position directly from the computed tomographic data and this information can be converted into guide templates to be used during surgery [38].

In addition, guided dynamic surgery reproduces the virtual implant position directly from computed tomographic data and uses motion-tracking technology to guide implant osteotomy preparation [39,40]. In this way, it became possible to plan the position of the optical implant virtually the ideal implant position, taking into account the adjacent vital anatomical structures and future prosthetic requirements [41].

Thus, the development of programs and the creation of bio models allowed the tactile perception of the anatomy of the region and the pathology understudy, enabling other advantages such as communication between the surgical team, help in communication with patients, simulation, and more detailed surgical planning, processing of personalized implants, reduction of surgery time, reduction of eventual complications during the surgical procedure [15,20]. In this sense, the most used imaging exam in dentistry capable of providing bio models is Computed Tomography (CT), which allows for a three-dimensional assessment of the individual anatomy of patients [20].

One study evaluated the linear and angular deviations of implants installed using the CG technique by CT [37]. Eighteen patients participated. Ten patients had a completely toothless jaw and eight had a completely toothless jaw. Patients received a total of 115 implants, of which 81 implants were installed in the maxilla and 34 were installed in the mandible. There were no differences in linear and angular deviations of implants installed in the maxilla and mandible. Compared to the coronal region, there was a trend towards greater linear deviations in the apical regions of the implants and a greater tendency towards deviations in the posterior regions than in the anterior regions of both arches. Therefore, CT CG promoted the installation of implants with high precision and allowed the installation of straight abutments in all evaluated cases. Linear deviations were not different in different regions of the month and in different portions of implants [37].

Another study looked at the improvement of mandibular function, facial esthetics, and quality of life after reconstruction of complex mandibular defects using the patient-specific three-dimensional titanium implant, with a total of seven patients. There was a significant improvement in aesthetics, function, and quality of life. The concept of using custom implants with the help of 3D virtual treatment planning, stereolithographic models, and computer-assisted design greatly improves mandibular restoration and helps to achieve a good facial profile, esthetics, and dental rehabilitation preventing serious complications related to autologous grafts [38].

In this sense, CG is considered accurate and reliable compared to free implant surgery [39]. Implants can be planned from radiographic guide information according to a restored treatment plan. Thus, one study described the use of a digitally designed prosthetic shell to improve the planning accuracy of the weld-guided approach for immediate abutment-supported restorations. As a result, importing the virtual shell into the planning program provided an effective protocol for using definitive information from the prosthetic space to predict the shape and position of the structure predictably, increasing the accuracy of guided planning and reducing the time required for realign the prosthetic shell [40].

Besides, a randomized study compared the precision of guided planning of new computer-assisted implant placement techniques, based on models using CAD/CAM stereolithographic surgical models with or without metallic sleeves. Forty-one implants were placed using surgical templates with metal sleeves, while 49 implants were placed using a surgical mold without metal sleeves. Of these, 16 implants were placed through open sleeves and 33 through closed sleeves. Surgical models without metallic sleeves were more accurate in the vertical plane and the angle compared to the conventional model. Open sleeves should be used with caution in the molar region only in case of reduced space between squares [41].

Also, a study evaluated the effects of guided preoperative planning and mandibular reconstruction guided by dental implant rehabilitation on dental prosthesis rehabilitation after mandibular reconstruction. Implant surgery was performed 6 months after reconstructive surgery. A total of 101 implants (16 patients) were inserted, and the implant success rate was 98.02%. Preoperative guided planning and dental implant guided jaw reconstruction through preoperative designs can provide a good opportunity to achieve high implant and dental rehabilitation success rates. This method can also benefit prosthetic restorations supported by fixed implants. Furthermore, the use of navigation after guided planning does not affect the type of prosthetic reconstruction [42].

Based on the literary findings presented above, it is possible to develop a method of preoperative planning, associated with the field of implant dentistry, using digital images [43]. Still, to the conventional surgical guide, it presented some advantages such as being cheaper, simple and easy to perform, however it leads to a greater operative risk for the patient. However, the accuracy of the location to be implanted is not the best and there is a greater probability of this guide becoming worn, due to the contact of the drills with it [44].

## Conclusion

Studies have shown that guided preoperative planning and dental implant-guided jaw reconstruction provide high success rates for implant and dental rehabilitation. Furthermore, the concept of using personalized implants with the help of 3D virtual treatment planning can greatly improve mandibular restoration and help to achieve good facial profile, esthetics and dental rehabilitation, avoiding complications with grafts in general.

## Acknowledgement
Not applicable.

## Funding
Not applicable.

## Data sharing statement
No additional data are available.

## Conflict of interest
The authors declare no conflict of interest.

## Similarity check
It was applied by Ithenticate@.

## About the License


## References

1. You JS, Kim SG, Oh JS, Kim JS. Effects of Platelet-Derived Material (Platelet-Rich Fibrin) on Bone Regeneration. Implant Dent. 2019 Mar 8 [doi: 10.1097/ID.0000000000000877].
2. Pye AD, Lockhart DEA, Dawson MP, Murray CA, Smith AJ. A review of dental implants and infection. J Hosp Infect ; 2009, 72:104–110.
3. bra°nemark PI, Hansson BO, Adell R, Breine U, Lindstrom J, Hallen O et al. Osseointegrated implants in the treatment of edentulous jaw. Experience from a 10-year period. Scand J Plast Reconstr Surg Suppl 16:1–192, 1977.
4. Bugarin Júnior JG, Garrafaii V. Bioethics and biosafety: the use of biomaterials in dental practice. Rev Saúde Pública;41(2):223-8, 2007.
5. Abdel-Kader, M.A., Abdelazeem, A.F., Ahmed, N.E.B., Khalil, Y.M., Mostafa, M.I. Oral rehabilitation of a case with regional odontodysplasia using a regenerative approach-A case report and a review of literature. Spec Care Dentist. 2019, May;39(3):330-339. doi: 10.1111/scd.12378. Epub 2019 Apr 16.
6. Arab, H., Shiezadeh, F., Moeintaghavi, A., Anbiaei, N., Mohamadi, S. Comparison of Two Regenerative Surgical Treatments for Peri-Implantitis Defect using Natix Alone or in Combination with Bio-Oss and Collagen Membrane. J Long Term Eff Med Implants. 2016;26(3):199-204. doi: 10.1615/JLongTermEffMedImplants.2016016396.
7. Chiapasco M., Casentini P., Zaniboni M. Bone augmentation procedures in implant dentistry. Int J Oral Maxillofac Implants. 2009;24 Suppl: 237-59.
8. Choukroun J, Diss A., Simonpieri A, Girard M.O. Schhoffler C., Dohan S.L., et al.Platelet-rich-fibrin (PRF): a second generation platelet concentrate. Part IV: clinical effects on tissue healing. Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod 2006: 101 (3): e 56 – 60.
9. Diana, C., Mohanty, S., Chaudhary, Z., Kumari, S., Dabas, J., Bodh, R. Does platelet-rich fibrin have a role in osseointegration of immediate implants? A randomized, single-blind, controlled clinical trial. Int J Oral Maxillofac Surg. 2018 Sep;47(9):1178-1188. doi: 10.1016/j.ijom.2018.01.001. Epub 2018 May 7.
10. Canellas JVDS, Drugos L, Ritto FG, Fischer RG, Medeiros PJD. Xenograft materials in maxillary sinus floor elevation surgery: a systematic review with network meta-analyses. Br J Oral

Maxillofac Surg. 2021 Feb 23:S0266-4356(21)00075-9. doi: 10.1016/j.bjoms.2021.02.009. Epub ahead of print. PMID: 34120778.

11. Kyyak S, Blatt S, Schiegnitz E, Heimes D, Staedt H, Thiem DGE, Sagheb K, Al-Nawas B, Kämmerer PW. Activation of Human Osteoblasts via Different Bovine Bone Substitute Materials With and Without Injectable Platelet Rich Fibrin in vitro. Front Bioeng Biotechnol. 2021 Feb 17;9:599224. doi: 10.3389/fbioe.2021.599224. PMID: 33681155; PMCID: PMC7925396.
12. Shen MH, Huang YL, Li Z, Zhang YD, He YP, Wang L. [Effect of platelet rich fibrin combining with Bio-oss to treat furcation involvement]. Shanghai Kou Qiang Yi Xue. 2018 Oct;27(5):508-512. Chinese. PMID: 30680396.
13. Xuan F, Lee CU, Son JS, Jeong SM, Choi BH. A comparative study of the regenerative effect of sinus bone grafting with platelet-rich fibrin-mixed Bio-Oss® and commercial fibrin-mixed Bio-Oss®: an experimental study. J Craniomaxillofac Surg. 2014 Jun;42(4):e47-50 [ doi: 10.1016/j.jcms.2013.05.029. Epub 2013 Aug 2].
14. Mazaro JVQ, Godoy PAI, Junior JFS, Mello CC, Pellizzer EP, Zavanelli AC; Regeneração óssea guiada em implantodontia: relato de caso; RFO, Passo Fundo, v. 19, n. 1, p. 121-128, 2014.
15. Tahmaseb A, Wu V, Wismeijer D, et al. The accuracy of static computer-aided implant surgery: a systematic review and meta-analysis. Clin Oral Implants Res; 29(Suppl 16):416–35, 2018.
16. Tahmaseb A, Wismeijer D, Coucke W, et al. Computer technology applications in surgical implant dentistry: a systematic review. Int J Oral Maxillofac Implants; 29(Suppl):25–42, 2014.
17. Jung RE, Schneider D, Ganeles J, et al. Computer technology applications in surgical implant dentistry: a systematic review. Int J Oral Maxillofac Implants; 24(Suppl):92–109, 2009.
18. D'Haese J, Van De Velde T, Komiyama A, et al. Accuracy and complications using computer-designed stereolithographic surgical guides for oral rehabilitation by means of dental implants: a review of the literature. Clin Implant Dent Relat Res;14:321–35, 2012.
19. Oh JH, An X, Jeong SM, et al. Digital workflow for computer-guided implant surgery in edentulous patients: a case report. J Oral Maxillofac Surg ;75: 2541–9, 2017.
20. El Kholy K, Janner SFM, Schimmel M, et al. The influence of guided sleeve height, drilling distance, and drilling key length on the accuracy of static computerassisted implant surgery. Clin Implant Dent Relat Res;21(1):101–7, 2019.
21. Zhou W, Liu Z, Song L, et al. Clinical factors affecting the accuracy of guided implant surgery- a systematic review and meta-analysis. J Evid Based Dent Pract;18:28–40, 2018.
22. Raico Gallardo YN, Da Silva-Olivio IRT, Mukai E, et al. Accuracy comparison of guided surgery for dental implants according to the tissue of support: a systematic review and meta-analysis. Clin Oral Implants Res;28:602–12, 2017.
23. Seo C, Juodzbalys G. Accuracy of guided surgery via stereolithographic mucosa-supported surgical guide in implant surgery for edentulous patient: a systematic review. J Oral Maxillofac Res;9:e1, 2018.
24. Cassetta M, Bellardini M. How much does experience in guided implant surgery play a role in accuracy? A randomized controlled pilot study. Int J Oral Maxillofac Surg;46:922–30, 2017.
25. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021; 372 doi: https://doi.org/10.1136/bmj.n71
26. H Balshem H, Grade guidelines: 3 ratng the quality of evidence. Journal of Clinical Epidemiology, Maryland Heights, 64 (4) (2011) 401-406.
27. Higgins, S Green, Cochrane Handbook for Systematic Reviews of Interventions. Version 5.1.0 [updated March 2011]. The Cochrane Collaboration; 2011.
28. Neto, R.M.S., Zotarelli-Filho , I.J. & Ribeiro da Silva, C.E.X.S. Meta-analysis of the Major Clinical Results of the Treatment with 1-Point Fixation in Fractures in the Zygomatic-Maxillary Complex: Success Rate and Complications. J. Maxillofac. Oral Surg. (2021). https://doi.org/10.1007/s12663-021-01603-3
29. Fang J, Xin XR, Li W, Wang HC, Lv HX, Zhou YM. Immediate implant placement in combination with platelet rich-fibrin into extraction sites with periapical infection in the esthetic zone: A case report and review of literature. World J Clin Cases. 2021 Feb 6;9(4):960-969. doi: 10.12998/wjcc.v9.i4.960. PMID: 33585645; PMCID: PMC7852644.
30. Starch-Jensen, T., Aludden, H., Hallman, M., Dahlin, C., Christensen, A.E., Mordenfeld, A. A systematic review and meta-analysis of long-term studies (five or more years) assessing maxillary sinus floor augmentation. Int J Oral Maxillofac Surg. 2018 Jan;47(1):103-116. doi: 10.1016/j.ijom.2017.05.001. Epub 2017 May 22.

31. Strauss, F.J., Stähli, A., Gruber, R. The use of platelet-rich fibrin to enhance the outcomes of implant therapy: A systematic review. Clin Oral Implants Res. 2018 Oct;29 Suppl 18:6-19. doi: 10.1111/clr.13275.
32. Zhou J, Li X, Sun X, Qi M, Chi M, Yin L, Zhou Y. Bone regeneration around immediate placed implant of molar teeth with autologous platelet-rich fibrin: Two case reports. Medicine (Baltimore). 2018 Nov;97(44):e13058. doi: 10.1097/MD.0000000000013058.
33. Kempraj J, Sundaram SS, Doss GPT, Nakeeran KP, Raja VBKK. Maxillary Sinus Augmentation Using Xenograft and Choukroun's Platelet-Rich Fibrin as Grafting Material: A Radiological Study. J Maxillofac Oral Surg. 2020 Jun;19(2):263-268. doi: 10.1007/s12663-019-01197-x. Epub 2019 Feb 26. PMID: 32346238; PMCID: PMC7176753.
34. Li P, Zhu H, Huang D. Autogenous DDM versus Bio-Oss granules in GBR for immediate implantation in periodontal postextraction sites: A prospective clinical study. Clin Implant Dent Relat Res. 2018 Dec;20(6):923-928. doi: 10.1111/cid.12667. Epub 2018 Sep 19.
35. Moreira AC, Silva JR, Samico RP, Nishioka GNM, Nishioka RS. Application of Bio-Oss in tissue regenerative treatment prior to implant installation: literature review. Braz Dent Sci. 22(2), 2019.
36. Rungcharassaeng K, Caruso JM, Kan JY, et al. Accuracy of computer-guided surgery: a comparison of operator experience. J Prosthet Dent;114:407–13, 2015.
37. Shenaq DS, Matros E. Virtual planning and navigational technology in reconstructive surgery. J Surg Oncol. Oct;118(5):845-852. doi: 10.1002/jso.25255. Epub 2018 Oct 7, 2018.
38. D'Haese J, Ackhurst J, Wismeijer D, De Bruyn H, Tahmaseb A. Current state of the art of computer-guided implant surgery. Periodontol 2000. 2017 Feb;73(1):121-133. doi: 10.1111/prd.12175.
39. Pommer B, Busenlechner D, Fürhauser R, Watzek G, Mailath-Pokorny G, Haas R. Trends in techniques to avoid bone augmentation surgery: Application of short implants, narrow-diameter implants and guided surgery. J Craniomaxillofac Surg. 2016 Oct;44(10):1630-1634. doi: 10.1016/j.jcms.2016.08.012. Epub 2016 Aug 21.
40. Oliveira G, Mattos W, Albaricci M, Marcantonio É, Queiroz T, Margonar R. Original Research: Analysis of linear and angular deviations of implants installed with a tomographic guided surgery technique. A prospective cohort-study. J Oral Implantol. 2019 Jun 17. doi: 10.1563/aaid-joi-D-18-00265.
41. Al Yafi F, Camenisch B, Al-Sabbagh M. Is Digital Guided Implant Surgery Accurate and Reliable? Dent Clin North Am. 2019 Jul;63(3):381-397. doi: 10.1016/j.cden.2019.02.006. Epub 2019 Apr 12.
42. Albiero AM, Benato R, Momic S, Degidi M. Guided-welded approach planning using a computer-aided designed prosthetic shell for immediately loaded complete-arch rehabilitations supported by conometric abutments. J Prosthet Dent. 2019 May 8. pii: S0022-3913(18)30742-X. doi: 10.1016/j.prosdent.2018.12.002.
43. Tallarico M, Martinolli M, Kim Y, Cocchi F, Meloni SM, Alushi A, Xhanari E. Accuracy of Computer-Assisted Template-Based Implant Placement Using Two Different SurgicalTemplates Designed with or without Metallic Sleeves: A Randomized Controlled Trial. Dent J (Basel). 2019 Apr 2;7(2). pii: E41. doi: 10.3390/dj7020041.
44. Zhu H, Zhang L, Cai Z, Shan X. Dental Implant Rehabilitation After Jaw Reconstruction Assisted by Virtual Surgical Planning. Int J Oral Maxillofac Implants. 2019 Feb 19. doi: 10.11607/jomi.7278.