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Systematic Review

Customized versus titanium healing abutments for preimplant tissue healing in fresh socket implants: A systematic review

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ABSTRACT

Background: It is suggested to use a customized abutment confirming to the configuration of the new extraction socket. Since there are no systematic reviews regarding this issue, the aim of this systematic review was to assess the efficacy of customized healing abutments versus titanium healing abutments on peri-implant tissue healing in fresh socket implants to improve the treatment prognosis in the clinic.

Materials and Methods: Electronic searches were conducted on PubMed/MEDLINE, Embase, Cochrane, and Google Scholar databases by the end of June 2022. All randomized controlled studies, prospective, retrospective, human studies of preimplant tissue healing around customized or titanium healing abutments, follow-up studies of more than 6 months, and in English were included in this study. The exclusion criteria were studies that were not clinical, with a follow-up period of <6 months, and those that assessed abutment healing.

Results: Forty-six studies were obtained following database research. Based on the eligibility criteria, five studies were finally included. Qualitative data analysis showed that two studies reported that customized abutments caused a significant decrease in a buccolingual width while two others did not report accurate results. Furthermore, one study only pointed to the significance of this change within 1 month after implant placement. Consequently, customized healing abutments may cause higher volume changes in the presence of thin bone phenotypes and facilitate the closure of large sockets. In addition, these investigations reported the same implant survival rate during the follow-up period for both methods.

Conclusion: Customized healing abutments exhibit efficacy in sealing immediate implant sockets, particularly in cases with thin bone phenotypes. These abutments induce significant volume changes, aiding in the closure of larger sockets and thereby preserving the socket volume.

Key Words: Customized healing abutment, fresh socket, titanium healing abutments

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INTRODUCTION

Immediate implantation of the implant in the extraction site reduces surgical cases, the length of the treatment period, and the patient's feeling of satisfaction with the healing process. However, using an implant immediately after extraction may cause thinning of the jawbone. This can also cause a facial recession and esthetic problems.[1-3]

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The thickness of the bone plate and gingiva play an essential role in the outcome of a successful surgery on an immediate implant. Furthermore, a suitable distance between the implant and the bone is critical in reconstructing and forming new bone around implants.[4,5]

Filling the gap between the implant and the socket wall with bone filler compounds can benefit the aesthetic results of the immediate implant. For example, the filling materials in the gap of the extraction cavity can protect the gingiva and bone structure. Still, it may damage the temporary crown or cause problems in significant gaps.[6,7] Based on the results of clinical studies, it is suggested to use a customized abutment similar to the structure of the new extraction socket.

The study by Choorak *et al*. evaluated the soft-tissue change after placing an immediate implant with a customized healing abutment on posterior teeth in a 6-month follow-up.[8] Fernandes *et al*. demonstrated that the immediate use of implants, along with bone substitutes and collagen matrices, could reduce the amount of erosion in the areas surrounding the implant. Therefore, customized healing abutments can be proposed as an alternative for sealing the socket and maintaining the soft tissue contour. Fernandes *et al*. studied the changes in peri-implant tissues after using custom-healing abutments compared to xenogeneic collagen matrices in flapless maxillary immediate implant implantation.[9] Hu *et al*. investigated the changes in the hard and soft tissue around immediate implants using two types of abutments.[10] Menchini-Fabris *et al*. examined the two different methods of tissue recovery on the alveolar ridge width over 3 years after implant placement in a fresh extraction socket.[11] Giovanni-Battista *et al*. compared customized and standard therapeutic abutments, evaluating alveolar bone in new socket implants.[12] However, the results of previous studies are not in agreement with each other. In addition, there are no systematic reviews regarding this issue. The aim of this study is to systematically review the efficacy of customized healing abutments versus titanium healing abutments for peri-implant tissue healing in fresh socket implants.

MATERIALS AND METHODS

Study design

This study was designed based on the Cochrane[13] criteria for systematic review and reported cases as per the Preferred Reporting Elements for Systematic Reviews and Meta-analyses.[14]

Search strategy

Literature searches in the following databases, including the PubMed, MEDLINE, Embase, Google Scholar, and Cochrane databases, were conducted using the appropriate keyword (MeSH). The clinical issue (PICO) was organized according to the population (patients receiving implants), intervention (patients with customized abutment), comparison (comparison with patients with standard abutment), and outcome (preimplant tissue healing as the main outcome). The searched words were: customized healing abutment OR titanium healing abutments AND preimplant tissue healing AND fresh socket implants.

Inclusion and exclusion criteria

Inclusion criteria included the following: All randomized controlled studies, prospective, retrospective, human studies of preimplant tissue healing around customized or titanium healing abutments, follow-up superior to 6 months, and in English. The exclusion criteria were studies that were not clinical, the with follow-up period was <6 months, and studies that assessed abutment healing. Table 1 shows the inclusion and exclusion criteria of the selected articles.

Search strategy and data extraction

Literature searches in the following databases, including the PubMed MEDLINE, Embase, Cochrane databases, and first 100 hit of Google Scholar, were conducted using the appropriate keyword June 2022. The searched words were: customized healing abutment OR titanium healing abutments AND preimplant tissue healing AND fresh socket implants [Table 2]. In addition, the reference list of selected papers was searched. The search results were exported to EndNote, where duplicate publications were identified and eliminated. The studies were screened based on the title and abstract. Then, the articles were selected by full-text screening following the eligibility criteria. Studies without the required information were excluded. The data included were extracted using a predesigned data sheet. The electronic database search, study selection and data extraction were done by two independent researchers. In case of disagreement, a third researcher was consulted to solve the problem.

Table 1: Inclusion exclusion criteria of selected studies

	Inclusion	Exclusion
Choorak *et al*., 2021	Healthy patients (ASA class I or II), aged ≥18 years, with acceptable oral hygiene and had adequate hard tissue volume for implant engagement	Patients with severe periodontitis, severe infection, uncontrolled diabetes, pregnancy, smoking ≥10 cigarettes/day or presence of any medical conditions which contraindicate implant placement (such as immunosuppressive taking, bisphosphonates taking, radiochemotherapy)
Fernandes *et al*., 2021	(1) ≥18 years of age; (2) patients who had a failing tooth and needed an implant placing therapy in the aesthetic zone (between 15 and 25); (3) the failing tooth has adjacent and opposing natural teeth; (4) sufficient mesialdistal and interocclusal space for placement of the implant and definitive restoration; (5) had an intact socket wall previously to the extraction; (6) had sufficient apical bone to place an immediate implant with minimum primary stability of 30 Ncm	(1) Individuals diagnosed with periodontal disease; (2) medical and general contraindications for the surgical procedure; (3) heavy smokers (>10 cigarettes per day); (4) an active infection at the implant site
Menchini-Fabris *et al*., 2020	Implant placement in a fresh extraction socket following either a conventional healing procedure with a cover screw or a CHA fabricated through a CAD/CAM process. Rehabilitation with a fixed single crown. Presence of at least 4 mm of bone beyond the root apex. Follow-up of 3 years from the date of implant placement	They had undergone any surgical treatment in the selected site different from that described above (tissue augmentation/filling material); or they reported the presence of dehiscence or fenestration of the residual bony walls of the alveolus
Giovanni-Battista *et al*., 2019	Need of extraction of maxillary anterior teeth (from premolar to premolar) due to root fractures, decays, endodontic lesions, or periodontal disease; patients in good general health (without chronic systemic diseases); presence of four bony walls of the alveolus; presence of at least 4 mm of bone beyond the root apex; rehabilitation with dental implants, placed in the fresh extraction sockets; both customized and standard healing abutment; CBCT scans before tooth extraction and after surgery (2–3 years)	Report of dehiscence or fenestration in the residual bony walls after tooth extraction; report of acute infection at implant site and healing; heavy smoking habit (>10 cigarettes a day); alcohol or drug abuse, and oral parafunctional habits (bruxism)
Hu *et al*., 2018	(1) Patients aged older than 18 years; (2) being systemically healthy; (3) hopeless posterior tooth because of caries, periapical lesions, nonactive periodontal disease, endoperio disease, or tooth fracture; and (4) sufficient native bone to achieve primary stability	(1) Acute infection in the area that will receive an implant; (2) heavy smokers (10 cigarettes per day); and (3) pregnant women

CBCT: Cone-beam computed tomography; CAD: Computer-aided design; CAM: Computer-aided manufacturing; ASA: American Society of Anesthesiologist; CHA: Customized healing abutment

RESULTS

Searching the databases resulted in the retrieval of 46 recorded [Figure 1]. Only 25 titles and abstracts of the paper were selected based on comparative inclusion and exclusion criteria. After reading all the articles, the other 20 studies were omitted because they lacked the required information. A diagram of the research workflow is shown in Figure 1. A total of 5 studies were included in the study for qualitative evaluation, including one randomized controlled trial study,[9] two prospective clinical studies[8,10] and two retrospective experiences.[11,12] The total number of implants in these five studies involved 170 oral implants in 123 patients. Table 1 presents the main results of the surveys. In the study of Choorak *et al*., patients received immediate implants through bone grafting and customized healing abutment. Before, immediately, and 1, 3, and 6 months after extraction, silicone molds were prepared, scanned, and measured. The obtained data were analyzed by Friedman and Wilcoxon tests.[8] A study by Fernandes *et al*. was designed as a prospective, randomized, controlled clinical trial. In this study, patients were divided into two groups depending on the socket sealing option: In one group, collagen matrix was used, and in the other group, the customized abutment was used. They took digital casts before extraction and 1, 4, and 12 months after implant placement to determine linear and volumetric changes between different time points in the peri-implant tissue areas.[9] Hu *et al*. used a modified osteotomy technique to place 28 immediate implants in molar/premolar sockets in their study. They also used protein-free bovine bone minerals to bridge the implants' gaps. The implants of the control group were connected using titanium healing abutments, and the treatment group was connected using customized healing abutments and were followed up for 6 months.[10] In the study of Menchini-Fabris *et al*., the sockets were immediately implanted after tooth extraction. The implants were reviewed retrospectively in two groups. First, the conventional group was treated with a standard package with a cover screw. In contrast, in the custom group, a custom abutment made with computer-aided design (CAD)/computer-aided manufacturing (CAM) technology was immediately screwed onto the head,

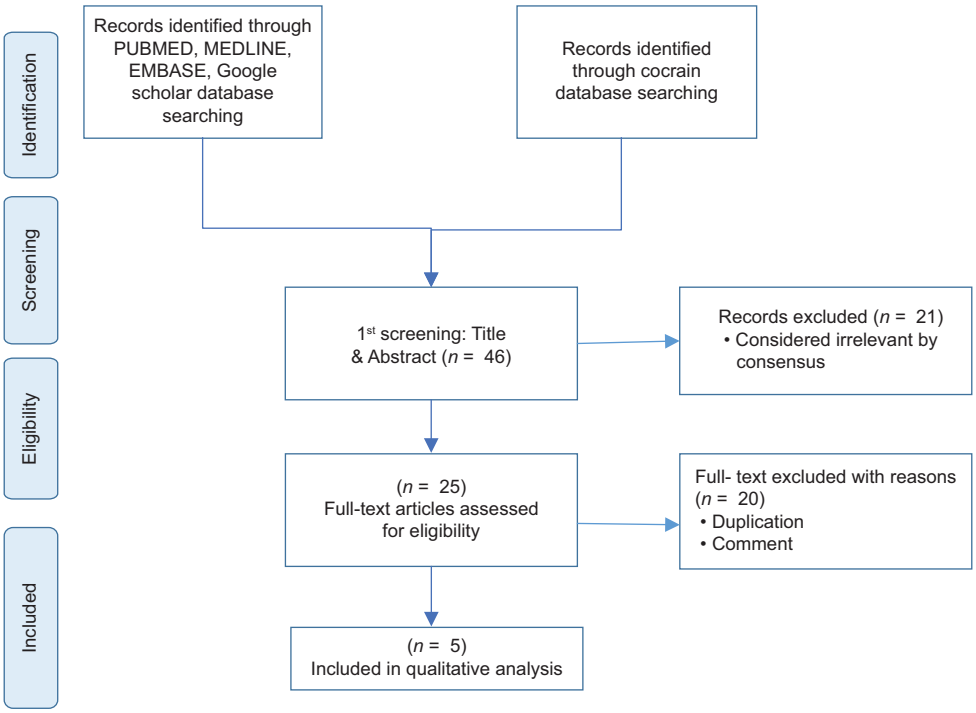

Figure 1: Flow chart for studies were identified, displayed and included in the study.

Table 2: Specific search strategy for each database

Database	Keyword
PubMed	("customized healing abutment" OR "titanium healing abutments") AND ("preimplant tissue healing") AND ("fresh socket implants")
Embase	(customized healing abutment"/exp OR titanium healing abutments") AND ("preimplant tissue healing"/exp) AND ("fresh socket implants")
Google Scholar	(customized healing abutment OR titanium healing abutments) AND (peri implant tissue healing) AND (fresh socket implants)
Cochrane	(*customized healing abutment) OR (titanium healing abutments):ti, ab, kw AND (preimplant tissue healing):ti, ab, kw AND (fresh socket implants):ti, ab, kw

and the width of the alveolar ridge was measured at 3 years.[11] Giovanni-Battista *et al*. immediately implanted the postextractive sockets without filling the space between the implant surface and the socket wall. In addition, they measured the width of the alveolar ridge after implant placement with or without a custom abutment up to 3 years after surgery [Table 3].[12]

DISCUSSION

In general, for planning a suitable treatment plan for each individual, the decision to use a customized abutment is complicated. However, clinical information is needed to help practitioners decide. Therefore, the results of this systematic review may help make an appropriate treatment decision. The present study investigated the effect of two groups of implants associated with different therapeutic abutments on the initial healing process [Table 3].

Studies have shown that implant components play a role in inducing a local or systemic inflammatory reaction.[15] Using acrylic materials in combination with customized abutments can cause allergies in sensitive people and disrupt the healing process. Therefore, there is a need to use tissue-compatible compounds in the manufacture of customized abutments. The declaration of the study by Choorak *et al*. was that immediate implant placement with customized healing abutment could maintain the architecture and horizontal dimension of transmucosal tissue but can keep the vertical measurement of lingual height and buccolingual width during 6 months' follow-up.[8]

That study also showed that the soft-tissue made the most significant changes in the 1st month, and after that, the tissue dimensions remained constant except for the buccal side. During 3 months, the buccolingual width changed significantly. Furthermore, after 6 months of follow-up, lingual height showed a significant difference.[8]

The findings of Fernandes *et al*. showed a significant difference between the average values of buccal volume in the 1st month in both groups during 1 year of follow-up. Still, this difference was not practical

Table 3: Baseline characteristics of studies assessing the customized healing abutment

Author (year)	Number of patients	Number of implants	Study type	Follow-up period (months)	Teeth	Population	Interventions	Outcomes accessed	Main results
Choorak *et al.*, 2021	16	16	P	6	Posterior teeth	Healthy patients (ASA class I or II), aged ≥18 years, with acceptable oral hygiene and had adequate hard tissue volume for implant engagement	CHA	That the soft tissue made the most significant changes in the 1st month, and after that, the tissue dimensions remained constant except for the buccal side. During 3 months, the buccolingual width changed significantly. Also, after 6 months of follow-up, lingual height showed a significant difference	CHA could maintain the architecture and horizontal dimension of transmucosal tissue but can keep the vertical measurement of lingual height and buccolingual width during 6 months follow-up
Fernandes *et al.*, 2021	28	28	RCT	12	Maxillary arch	Patients who had a failing tooth and needed an implant placing therapy in the aesthetic zone	CHAs compared with the use of xenogeneic collagen matrices as socket sealing options	A significant difference between the average values of buccal volume in the 1st month in both groups during 1 year of follow-up. Still, this difference was not practical for 1 year between the two groups. Also, no significant difference was observed in the change of midfacial mucosa and papilla between the groups	Both treatment options could be predictable solutions for sealing immediate implant sockets. However, higher volume changes can be expected in the presence of thin bone phenotypes
Menchini-Fabris *et al.*, 2020	30	54	Retrospective	36	Maxilla and mandibula	Patients requiring tooth extractions from the premolar-to-premolar regions of the maxilla and mandible due to root fractures, caries, endodontic lesions or periodontal disease	Two different methods of tissue improvement on the amount of alveolar ridge width	The survival rate of 54 dental implants for all implants was reported as 100% after 36 months. However, the decrease in bone width for the customized group was significantly smaller than that of the conventional group	The CAD/CAM method could have advantages such as stabilization of bone volume in a new socket implant, and it also causes constant growth of teeth for restorative veneers. Finally, optimal prosthetic-surgical planning and minimally invasive extraction are necessary to maintain the integrity of the supporting tissue

Contd...

Table 3: Contd...

Author (year)	Number of patients	Number of implants	Study type	Follow-up period (months)	Teeth	Population	Interventions	Outcomes accessed	Main results
Giovanni-Battista *et al.*, 2019	22	44	Retrospective	36	Maxilla	Patients requiring extractions of teeth from premolar-to-premolar regions of the maxilla due to root fractures, caries, endodontic lesions, or periodontal disease	Compared customized and standard therapeutic abutments, evaluating alveolar bone in new socket implants	The survival rate of all 44 implants after 36 months was 100%. The bone width decreased in both groups, and the change in dimensions of the alveolar ridge in the customized group was insignificant compared to the standard group. Also, they observed a significant difference between the groups regarding tooth type	The customized method could help protect and support the natural appearance profile by creating a seal over the surgical site and preserving the socket volume
Hu *et al.*, 2018	27	28	P	6	Molar/premolar	-	Investigated the changes in the hard and soft tissue around immediate implants using two types of abutments	The amount of buccal and lingual bone loss was comparable between the two groups. On the other hand, changes in buccal bone thickness were similar between the two groups, and the soft tissue surface of the middle face was well preserved in both groups	CHAs can facilitate the closure of large sockets. Despite more pronounced incomplete filling, healing abutments composed of ketone polyether ether and resin did not pose an increased risk of peri-implant bone loss or soft tissue resorption during the initial healing period

P: Prospective observational study; RCT: Randomized, controlled clinical trial; CHA: Customized healing abutment; CAD: Computer-aided design; CAM: Computer-aided manufacturing; ASA: American Society of Anesthesiologist; CHA: Customized healing abutment

for 1 year between the two groups. Furthermore, no significant difference was observed in the change of midfacial mucosa and papilla between the groups.[9]

Hu *et al*. showed that the amount of buccal and lingual bone loss was comparable between the two groups. Changes in buccal bone thickness were similar between the two groups, and the soft-tissue surface of the middle face was well preserved in both groups.[10]

The findings of the study by Menchini-Fabris *et al*. showed that the survival rate of 54 dental implants for all implants was reported as 100% after 36 months. However, the decrease in bone width for the customized group was significantly smaller than that of the conventional group.[11]

Giovanni-Battista *et al*. reported that the survival rate of all 54 implants after 36 months was 100%. The bone width decreased in both groups, and the change in dimensions of the alveolar ridge in the customized group was insignificant compared to the standard group. Furthermore, they observed a significant difference between the groups regarding tooth type. In comparison to the other teeth (2.57 ± 0.53 mm and 2.36 ± 0.32 in the canine and premolar sites, respectively), the incisor teeth appeared to have considerably less bone loss (with a bone loss of 1.59 ± 0.44 mm).[12]

The study's conclusion by Fernandes *et al*. was that both treatment options could be predictable solutions for sealing immediate implant sockets. However, higher volume changes can be expected in the presence of thin bone phenotypes.[9] Hu *et al*. concluded that despite study limitations, for immediate implants placed in posterior sockets, customized healing abutments can facilitate the closure of large sockets. Despite more pronounced incomplete filling, healing abutments composed of ketone polyether ether and resin did not pose an increased risk of peri-implant bone loss or soft-tissue resorption during the initial healing period.[10]

Correcting and solving the problems of healing abutments can improve their performance. When there is a need to make customized therapeutic abutments with polished surfaces in the shortest possible time, using computer tools to prepare an ideal abutment can be very helpful.[16-18] The results of the study by Menchini-Fabris *et al*. showed that the CAD/CAM method could have advantages such as stabilization of bone volume in a new socket implant, and it also causes constant growth of teeth for restorative veneers. Finally, optimal prosthetic-surgical planning and minimally invasive extraction are necessary to maintain the integrity of the supporting tissue.[11]

An abutment with convenient features can help improve gingivally and bone tissue when immediate implant placement. Therefore, it can be effective in maintaining the socket's volume and the final restoration. During extraction, it is necessary to use customized abutments to protect the beauty and anatomy of the gingival, and it is considered the last step in implant surgery.[19-21] Giovanni-Battista *et al*. stated that the customized method could help protect and support the natural appearance profile by creating a seal over the surgical site and preserving the socket volume.[12]

Consequently, these findings illuminate the critical significance of material selection for therapeutic abutments, emphasizing the need for tissue-compatible compounds to avert allergic reactions and disruptions in the healing process, especially with immediate implant placement. Customized healing abutments, while maintaining tissue architecture and facilitating socket closure, necessitate attention to specific materials, such as ketone polyether ether and resin, to prevent adverse effects on bone loss or tissue resorption during initial healing stages. Incorporating CAD/CAM technology emerges as a promising avenue for expedited production of ideal abutments and stabilizing bone volume in new implant sockets.

This systematic review's limitations were confined to using only indexed publications in online databases and English articles. Hence, the authors recommend evaluating articles and studies from additional sources such as gray literature, books, and articles in different languages.

CONCLUSION

The study concludes that both treatment options could be predictable solutions for sealing immediate implant sockets. However, customized healing abutments exhibit efficacy in sealing immediate implant sockets, particularly in cases with thin bone phenotypes. These abutments induce significant volume changes such as size, aiding in the closure of larger sockets and thereby preserving the socket volume.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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