Table S1. (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	Title
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	Abstract
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	Initial introduction
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	End of introduction
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	Dedicated section in M&M
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	Dedicated section in M&M
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	Dedicated section in M&M
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Dedicated section in M&M
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	Dedicated section in M&M
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	Dedicated section in M&M
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	Dedicated

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
			section in M&M
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Dedicated section in M&M
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	Dedicated section in M&M
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Dedicated table
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Dedicated table
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Dedicated table
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Dedicated table
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	Dedicated table
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	Followed
Limitations	20	Discuss the limitations of the scoping review process.	Followed
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	Followed
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	None

Table S2: Search strategies for electronic databases.

Database	Search strategy
PubMed (MEDLINE)	#1 "Surgical Mesh" [MESH] OR (Meshes, Surgical) OR (Surgical Meshes) OR (Mesh, Surgical) #2 "Guided Tissue Regeneration" [MESH] OR (Tissue Regeneration) OR (Guided Regeneration) OR (Guided Tissue) #3 "Bone Regeneration" [MESH] OR (Bone Regenerations) OR (Regeneration, Bone) OR (Regenerations, Bone) OR (Osteoconduction) #4 "Printing, Three-Dimensional" [MESH] OR (Printing, Three Dimensional) OR (Printings, Three-Dimensional) OR (Three-Dimensional Printings) OR (3-Dimensional Printing) OR (Printing, 3-Dimensional) OR (Printings, 3-Dimensional) OR (3-D Printing) OR (Printing, 3-D) OR (Three-Dimensional Printing) OR (3D Printing) OR (Printing, 3D) #5 "Computer-Aided Design" [MESH] OR (Computer Aided Design) OR (Design, Computer-Aided) OR (Computer-Assisted Design) OR (Design, Computer-Assisted) OR (Computer-Aided Manufacturing) OR (Computer Aided Manufacturing) OR (Manufacturing, Computer-Aided) OR (Computer-Assisted Manufacturing) OR (Manufacturing, Computer-Assisted) OR (CAD-CAM) #6 "Digital Technology" [MESH] OR (Digital Technologies) OR (Technologies, Digital) OR (Technology, Digital) OR (Digital Electronics) OR (Electronics, Digital) #7 #1 AND #2 AND #3 #8 #1 AND #2 AND #3 AND #4 #9 #1 AND #2 AND #3 AND #5 #10 #1 AND #2 AND #3 AND #6

SCOPUS	#1 “Surgical Mesh” [MESH] OR (Meshes, Surgical) OR (Surgical Meshes) OR (Mesh, Surgical) #2 “Guided Tissue Regeneration” [MESH] OR (Tissue Regeneration) OR (Guided Regeneration) OR (Guided Tissue) #3 “Bone Regeneration” [MESH] OR (Bone Regenerations) OR (Regeneration, Bone) OR (Regenerations, Bone) OR (Osteoconduction) #4 “Printing, Three-Dimensional” [MESH] OR (Printing, Three Dimensional) OR (Printings, Three-Dimensional) OR (Three-Dimensional Printings) OR (3-Dimensional Printing) OR (Printing, 3-Dimensional) OR (Printings, 3-Dimensional) OR (3-D Printing) OR (Printing, 3-D) OR (Three-Dimensional Printing) OR (3D Printing) OR (Printing, 3D) #5 “Computer-Aided Design” [MESH] OR (Computer Aided Design) OR (Design, Computer-Aided) OR (Computer-Assisted Design) OR (Design, Computer-Assisted) OR (Computer-Aided Manufacturing) OR (Computer Aided Manufacturing) OR (Manufacturing, Computer-Aided) OR (Computer-Assisted Manufacturing) OR (Manufacturing, Computer-Assisted) OR (CAD-CAM) #6 “Digital Technology” [MESH] OR (Digital Technologies) OR (Technologies, Digital) OR (Technology, Digital) OR (Digital Electronics) OR (Electronics, Digital) #7 #1 AND #2 AND #3 #8 #1 AND #2 AND #3 AND #4 #9 #1 AND #2 AND #3 AND #5 #10 #1 AND #2 AND #3 AND #6

Table S3. Summary table of studies excluded in this systematic review**.**

Excluded Studies	Exclusion Reasons
Xie et al., 2020 **[1]**	Narrative review
Tolstunov et al., 2019 **[2]**	Narrative review
Zhou et al., 2022 **[3]**	Systematic review and meta-analysis
Herford et al., 2019 **[4]**	Narrative review
Casap et al., 2019 **[5]**	Narrative review
Trento et al., 2019 **[6]**	Systematic review
Lim et al., 2018 **[7]**	Systematic review and meta-analysis
Ricci et al., 2013 **[8]**	Systematic review
Rasia-dal Polo et al., 2014 **[9]**	Systematic review
Briguglio et al., 2019 **[10]**	Systematic review
Carini et al.,2014 **[11]**	Systematic review

Table S4. Criteria for judging risk of bias in the "Risk of bias" assessment tool.

Random Sequence Generation	
Criteria for a judgement of 'Low risk' of bias.	The investigators describe a random component in the sequence generation process.
Criteria for the judgement of 'High risk' of bias.	The investigators describe a non-random component in the sequence generation process. Usually, the description would involve some systematic, non-random approach. Other non-random approaches happen much less frequently than the systematic approaches mentioned above and tend to be obvious. They usually involve judgement or some method of non-random categorization of participants.
Allocation Concealment	
Criteria for a judgement of 'Low risk' of bias.	Participants and investigators enrolling participants could not foresee assignment because one of the following, or an equivalent method, was used to conceal allocation.
Criteria for the judgement of 'High risk' of bias.	Participants or investigators enrolling participants could possibly foresee assignments and thus introduce selection bias.
Blinding	
Criteria for a judgement of 'Low risk' of bias.	Any one of the following: - No blinding or incomplete blinding, but the review authors judge that the outcome is not likely to be influenced by lack of blinding; - Blinding of participants and key study personnel ensured, and unlikely that the blinding could have been broken; - No blinding of outcome assessment, but the review authors judge that the outcome measurement is not likely to be influenced by lack of blinding; - Blinding of outcome assessment ensured, and unlikely that the blinding could have been broken.
Criteria for the judgement of 'High risk' of bias.	Any one of the following: - No blinding or incomplete blinding, and the outcome is likely to be influenced by lack of blinding; - Blinding of key study participants and personnel attempted, but likely that the blinding could have been broken, and the outcome is likely to be influenced by lack of blinding;

	- No blinding of outcome assessment, and the outcome measurement is likely to be influenced by lack of blinding; - Blinding of outcome assessment, but likely that the blinding could have been broken, and the outcome measurement is likely to be influenced by lack of blinding.
Incomplete Outcome Data	
Criteria for a judgement of 'Low risk' of bias.	Any one of the following: - No missing outcome data; - Reasons for missing outcome data unlikely to be related to true outcome (for survival data, censoring unlikely to be introducing bias); - Missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups; - For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk not enough to have a clinically relevant impact on the intervention effect estimate; - For continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes not enough to have a clinically relevant impact on observed effect size; - Missing data have been imputed using appropriate methods.
Criteria for the judgement of 'High risk' of bias.	Any one of the following: - Reason for missing outcome data likely to be related to true outcome, with either imbalance in numbers or reasons for missing data across intervention groups; - For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk enough to induce clinically relevant bias in intervention effect estimate; - For continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes enough to induce clinically relevant bias in observed effect size; - 'As-treated' analysis done with substantial departure of the intervention received from that assigned at randomization; - Potentially inappropriate application of simple imputation.
Selective Reporting	

Criteria for a judgement of 'Low risk' of bias.	Any one of the following: - The study protocol is available and all of the study's pre-specified (primary and secondary) outcomes that are of interest in the review have been reported in the pre-specified way; - The study protocol is not available but it is clear that the published reports include all expected outcomes, including those that were pre-specified (convincing text of this nature may be uncommon).
Criteria for the judgement of 'High risk' of bias.	Any one of the following: - Not all of the study's pre-specified primary outcomes have been reported; - One or more primary outcomes is reported using measurements, analysis methods or subsets of the data (e.g., subscales) that were not pre-specified; - One or more reported primary outcomes were not pre-specified (unless clear justification for their reporting is provided, such as an unexpected adverse effect); - One or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis; - The study report fails to include results for a key outcome that would be expected to have been reported for such a study.

Table S5: Evidence of studies included in this scoping review.

Authors and Year of Publication	Study Design and Aim	Methods	Results	Conclusions
Cucchi et al., 2021 **[12]**	A 2 years randomized clinical trial to evaluate the role of resorbable membranes applied over customized titanium meshes related to soft tissue healing and bone regeneration after vertical/horizontal bone augmentation.	30 patients with partial edentulism of the maxilla/mandible, with vertical/horizontal reabsorption of the alveolar bone, and needing implant-supported restorations, were randomly divided into two groups: Group A was treated using only custom-made meshes (Mesh-) and Group B using custom-made meshes with cross-linked collagen membranes (Mesh+). Data collection included surgical/technical and healing complications, "pseudo-periosteum" thickness, bone density, planned bone volume (PBV), regenerated bone volume (RBV), regeneration rate (RR), vertical bone gain (VBG), and implant survival in regenerated areas. Statistical analysis was performed between the two study groups using a significance level of $\alpha = .05$.	Regarding the healing complications, the noninferiority analysis proved to be inconclusive, despite the better results of group Mesh+ (13%) compared to group Mesh- (33%): estimated value −1.13 CI-95% from −0.44 to 0.17. Superiority approach confirmed the absence of significant differences ($p = .39$). RBV was 803.27 mm^3 and 843.13 mm^3, respectively, and higher RR was observed in group Mesh+ (82.3%) compared to Mesh- (74.3%), although this value did not reach a statistical significance ($p = .44$). All 30 patients completed the study, receiving 71 implants; 68 out of them were clinically stable and in function.	The results showed that customized meshes alone do not appear to be inferior to customized meshes covered by cross-linked collagen membranes in terms of healing complication rates and regeneration rates, although superior results were observed in group Mesh+ compared to group Mesh- for all variables.

Mounir et al., 2019 **[13]**	A 6 months randomized clinical trial to assess three dimensional (3D) maxillary ridge augmentation using two innovative, accurate, and time saving protocols.	16 patients (32 implants) with vertically and horizontally deficient maxillary alveolar ridges, were equally allocated into 2 groups; a mix of particulate autogenous and xenogenic bone grafts loaded in a prebent titanium mesh (Control group) vs patient specific poly-ether-ether ketone meshes (Study group). Radiographic assessment was performed preoperatively, 1 week and 6 months postoperatively. Assessment included measurements of linear changes in the vertical and horizontal dimensions on cross sectional cuts of cone beam computed tomography using special software. Finally; the percentage of 3D bone gain in each group was compared to that of the other.	Wound healing was uneventful for all cases except one patient in each group were the meshes were exposed 2 weeks' postsurgery. There was no statistical significance between both groups (*P*-value = 0.2).	Within the limitations of the sample size of this study, both techniques could be used as a successful method of ridge augmentation with no statistical significance between them.

Cucchi et al., 2022 **[14]**	A pilot study to evaluate the clinical, radiographic and patient-related outcomes of a novel technique for digitalisation and customisation of reinforced polytetrafluoroethylene meshes in vertical ridge augmentation surgery.	10 patients with vertical defects were included in the study. Prior to surgery, digital planning of bone augmentation, manufacturing of 3D printed models and replicas of the meshes and modelling of a customised reinforced polytetrafluoroethylene mesh were carried out. All patients were treated using a 50:50 mixture of xenogeneic and autogenous bone, customised reinforced polytetrafluoroethylene mesh and collagen membrane. After 6 to 9 months, computer-guided surgery was planned, the reinforced polytetrafluoroethylene mesh was removed, and implants were placed in augmented sites using a fully guided surgical template. Patient-related outcomes, intraoperative timing, surgical and healing complications, vertical bone gain, bone density, pseudo periosteum type and number and stability of implants were recorded.	All 10 patients were treated without surgical complications. Healing was largely uneventful, with the exception of one case of abscess formation without mesh exposure. The mean duration of digital planning was 17.0 minutes, reinforced polytetrafluoroethylene mesh customization took 9.0 minutes, and the total intraoperative time was 91.3 minutes. The mean planned bone volume was 1.52 cc, vertical bone defect depth was 6.0 ± 1.7 mm and vertical bone gain was 5.5 ± 1.9 mm; most sites showed medium bone density and a Type 1 pseudo periosteum. All patient-related outcomes were favourable.	The preliminary results of this pilot study demonstrated the feasibility and reliability of a fully digital workflow for the customisation of reinforced polytetrafluoroethylene mesh in vertical ridge augmentation.

Lizio et al., 2022 **[15]**	A 52 months retrospective study to understand the use of customized titanium meshes to reconstruct complex and extended defects in terms of bone gain and exposure percentage, compared to the traditional manual approach.	19 large defects were digitally reconstructed using CT scans according to the prosthetic requirements. A titanium mesh scaffold was designed to cover the bone graft. At least 6 months after surgery, a new cone-beam CT was taken. The pre- and postoperative CT datasets were then converted into three-dimensional models and digitally aligned. The actual mesh position was compared to the virtual position to assess the reliability of the digital project. The reconstructed bone volumes (RBVs) were calculated according to the planned bone volumes (PBVs), outlining the areas under the mesh. These values were then correlated with the number of exposures, locations of atrophy, and virtually planned bone volume.	The mean matching value between the planned position of the mesh and the actual one was 82 ± 13.4%. 52.3% (40% early and 60% late) exposures were observed, with 15.8% exhibiting infection. 26.3% resulted as failures. The amount of reconstructed bone volume (RBV) in respect to PBV was 65 ± 40.5%, including failures, and 88.2 ± 8.32% without considering the failures. The results of the exposure event were statistically significant (p = .006) in conditioning the bone volume regenerated.	The study obtained up to 88% of bone regeneration in 74% of the cases. The failures encountered (26%) should underline the operator's expertise relevance in conditioning the final result.

Dellavia et al., 2021 **[16]**	A 1-year retrospective cohort study to assess the integration capabilities of these innovative meshes and to evaluate the histological features of the regenerated alveolar bone.	20 partially edentulous patients, with severe posterior mandibular atrophy, underwent a guided bone regeneration technique by means of customized CAD-CAM titanium mesh in association with a mixture of autologous bone in chips and deproteinized bovine bone (1:1). At 9 months of healing, titanium meshes and bone samples were collected and histomorphometrically analyzed.	At histologic analysis, mesh appeared well osteo-integrated, except that in sites where membrane exposure occurred. In all sites, newly formed tissue resulted highly mineralized, well-organized, and formed by 35.88% of new lamellar bone, 16.42% of woven bone, 10.88% of osteoid matrix, 14.10% of grafted remnants, and 22.72% of medullary spaces. Blood vessels were the 4% of the tissue.	Data from this study support the use of customized CAD/CAM titanium mesh for regeneration of vital, well-structured, and vascularized alveolar bone.
Ciocca et al., 2018 **[17]**	A 24 months preliminary prospective study to evaluate the outcomes of computer-aided design-computer-aided machining (CAD-CAM)-customized titanium mesh used for prosthetically guided bone augmentation related to the occlusion-driven implant position, to the vertical bone volume gain of the mandible and maxilla, and to complications, such as mesh exposure.	9 patients scheduled for bone augmentation of atrophic sites were treated with custom titanium mesh and particulate bone grafts with autologous bone and inorganic bovine bone in a 1:1 ratio prior to implant surgery. The bone volume needed to augment was virtually projected based on implants position, width and length, and the mesh design was programmed for the necessary retaining screws.	After 6-8 months, bone augmentations of 1.72 to 4.1 mm (mean: 3,83 mm) for the mandibular arch and 2.14 to 6.88 mm (mean: 3,95 mm) for the maxilla were registered on cone beam CT. Mesh premature (within 4 to 6 weeks) exposure was observed in three cases and delayed (after 4 to 6 weeks) in three other cases. One titanium mesh was removed before the programmed time, but in all augmented sites was possible implant insertion. No complication occurred during prosthetic follow-up.	CAD-CAM technology used for prosthetically guided bone augmentation showed important post-operative morbidity of mesh exposure (66%). Due to this high number of mesh exposure and the potential infection that could affect the expected bone augmentation, this study suggests a cautious approach to this procedure when designing the Ti-mesh, to avoid flap tension that may cause mucosal rupture.
Chiapasco et al., 2021 **[18]**	A 2 years retrospective clinical study to present the results of guided bone regeneration (GBR) of atrophic edentulous	41 patients, presenting with 53 atrophic sites, were enrolled. GBR was obtained with titanium meshes filled with autogenous bone chips and bovine bone	Out of 53 sites, 11 underwent mesh exposure: eight of them were followed by uneventful integration of the graft, while three by partial	Customized titanium meshes can represent a reliable tool for GBR of severely atrophic sites, with

	ridges with customized CAD/CAM titanium meshes.	mineral (BBM). After a mean of 7 months (range: 5–12 months), meshes were removed and 106 implants placed. After a mean of 3.5 months (range: 2–5 months), implants were uncovered and prosthetic restorations started. The outcomes were vertical and horizontal bone augmentation changes, biological complications and implant survival.	bone loss. The mean vertical and horizontal bone gain after reconstruction was 4.78 ± 1.88 mm (range 1.00–8.90 mm) and 6.35 ± 2.10 mm (range 2.14–11.48 mm), respectively. At the time of implant placement, mean changes of initial bone gain were −0.39 ± 0.64 mm (range −3.1 to + 0.80 mm) and −0.49 ± 0.83 mm (range −3.7 to +0.4 mm), in the vertical and horizontal dimensions, respectively. Reduction of bone volume was significantly higher ($p < .001$ for both dimensions) in the exposed sites. The mean follow-up of implants after loading was 10.6 ± 6.5 months (range: 2–26 months). The survival rate of implants was 100%.	simplification of the surgical phases.
Navarro Cuellar 2021 **[19]**	A 5 years retrospective clinical study to evaluate the outcomes of the three-dimensional reconstruction of the fibula flap with iliac crest graft and dental implants through virtual surgical planning (VSP), STL models and CAD/CAM titanium mesh.	8 patients underwent three-dimensional reconstruction of the fibula flap with iliac crest graft and dental implants through VSP, STL models and CAD/CAM titanium mesh. Vertical ridge augmentation and horizontal dimensions of the fibula, peri-implant bone resorption of the iliac crest graft, implant success rate and functional and aesthetic results were evaluated.	Vertical reconstruction ranged from 13.4 mm to 10.1 mm, with an average of 12.22 mm. Iliac crest graft and titanium mesh were able to preserve the width of the fibula, which ranged from 8.9 mm to 11.7 mm, with an average of 10.1 mm. A total of 38 implants were placed in the new mandible, with an average of 4.75 ± 0.4 implants per patient and an osseointegration success rate of 94.7%. Two implants were lost during the osseointegration period (5.3%). Bone resorption was measured as peri-implant bone	All patients were rehabilitated with a fixed implant prosthesis with good aesthetic and functional results.

			resorption at the mesial and distal level of each implant, with a variation between 0.5 mm and 2.4 mm, and with a mean of 1.43 mm.	
Yang et al., 2022 **[20]**	A 4 years retrospective clinical study to analyze and investigate the effect of bone defect size on the 3D accuracy of alveolar bone augmentation performed with additively manufactured patient-specific titanium meshes.	23 3D-printed patient-specific titanium mesh GBR surgery cases were enrolled, in which 10 cases were minor bone defect/augmentation and another 10 cases were significant bone defect/augmentation. 3D digital reconstruction/superposition technology was employed to investigate the bone augmentation accuracy of 3D-printed patient-specific titanium meshes.	There was no significant difference in the 3D deviation distance of bone augmentation between the minor bone defect/augmentation group and the major one. The contour lines of planned-CAD models in two groups were basically consistent with the contour lines after GBR surgery, and both covered the preoperative contour lines. Moreover, the exposure rate of titanium mesh in the minor bone defect/augmentation group was slightly lower than the major one.	It can be concluded that the size of the bone defect has no significant effect on the 3D accuracy of alveolar bone augmentation performed with the additively manufactured patient-specific titanium mesh.
Ghanaati et al., 2019 **[21]**	A 1-year case series to introduce a biomaterial-based regenerative concept in terms of exposed open healing to overcome the dehiscence related to 3D-titanium meshes.	7 patients with alveolar ridge atrophy with different etiologies (cancer resection, severe atrophy after tooth loss, aplasia, trauma, implant infections) were treated using the open-healing concept. Therefore, after 3D augmentation using the described biomaterials, the flap margins were approximated, and the gap between the flap margins was bridged using a collagen matrix loaded with liquid PRF that was then covered by either a PTFE-based membrane or sterile latex. No periosteum splitting was performed at any time point.	After a healing period of 4-8 months, all patients received dental implants as virtually planned. Bone biopsies were performed during dental insertion for histological evaluation. The augmentation area displayed a vital and well-vascularized newly formed bone that incorporated the BSM granules to build a hybrid bone. Additionally, open healing resulted in newly formed soft tissue without any signs of scar formation or fibrosis. The regenerated soft tissue was used to build a new flap during implant insertion and	The open-healing concept of the regeneration of the soft tissue along with bone tissue to regenerate a harmonic implantation bed is a minimally invasive intervention without periosteum splitting or large flap mobilization.

			showed good functional and aesthetic results after implant insertion.	
Boogaard et al., 2019 **[22]**	A 6 months case-series to achieve a stable peri-implant bone foundation as a highly predictable and successful treatment in dental implantology.	CAD-designed and CAM-manufactured custom-made titanium meshes were used in the rebuilding of lost hard tissues.	The case results showed the first patient presenting 4.1 mm vertical gain and a width of 8.7 mm and the second patient having 6.7 mm vertical gain and 10.8 mm width.	The two cases demonstrate that custom-made CAD/CAM titanium meshes are reliable and safe devices fur bone augmentation, especially for vertical and horizontal combined defects.
Nickenig et al., 2022 **[23]**	A 12 months case series to describe an optimized method for the treatment of screw-retained restoration of implants for biological and esthetic reasons; the clinical reliability is to be ascertained by means of measurements (before and after augmentation) and assigned to the current literature.	7 cases with buccal concavities of the anterior alveolar ridge were treated with optimized method, which is presented step-by-step until the prosthetic restoration. The depths of the bone concavities were measured and related to the bone gain after augmentation procedure respectively after implantation.	Linear measurements of the buccal concavities showed an average undercut of 4 mm [SD ± 1.13]. After healing period of six months, the buccal concavities could be compensated bony to such an extent that implants could be inserted in correct position and angulation. On average, there was a horizontal bone gain of 3.7 mm [*SD* ± 0.59]. Even after implantation and another six months of healing, stable bone dimensions could be assumed with an average of 4.3 [*SD* ± 0.83] mm of bone gain compared to baseline. In six of the seven cases, the favorite screw-retained, one-piece full-ceramic restoration could be fixed on the implants. Due to the implant axis, one case had to be treated with a cemented two-part full-ceramic system.	With the described optimized method the most favorable screw-retained restoration can also be used in situations with unfavorable concavities of buccal bone. Especially for this indication, a special form of the horizontal deficit, the customized bone regeneration with titanium meshes is highly reliable in terms of healing and extent of augmentation.

De Santis et al., 2022 **[24]**	A 12 months case series to evaluate the reliability of the Guided Bone Regeneration (GBR) surgical technique through the use of customized CAD CAM titanium meshes (Yxoss CBR®Reoss) in order to show an alternative method of bone augmentation.	9 patients presenting 10 bone defects were referred to solve oral dysfunction due to edentulous atrophic ridges. Guided bone regeneration was performed with titanium meshes combined with autogenous bone grafting and heterologous bovine bone mineral grafting, and exclusively a "poncho technique" soft tissue approach for all the cases. After a mean 9 months of graft healing (range 6-12 months), titanium meshes were removed, and implant surgery was subsequently performed. The results we obtained were positive in terms of volumetric increases in height, length and thickness of the atrophic ridges without biological complications detectable before implant surgery.	Out of nine, one site met titanium mesh exposure: however, in all 10 sites a three-dimensional volumetric bone implementation was obtained. The statistical results were estimated by uploading and superimposing cbct scans before and after CBR surgery for each patient, so it was possible evaluate the maximum linear vertical and horizontal bone gain through dedicated Cad Cam software (Exocad GmbH®). The average horizontal gain was 6.37 ± 2.17 mm (range 2.78-9.12 mm) and vertical gain was 5.95 ± 2.06 mm (range 2.68-9.02 mm). A total of 18 implants were placed into the grafted sites with a 100% survival rate (clearly they are relative percentages to be compared to the short time elapsed).	The results we obtained in this study suggest that this CBR procedure (Yxoss® by Reoss) is reliable and safe for bone regeneration to allow implant-prosthetic restoration in horizontal, vertical and combined bone defects. The soft tissue management is diriment: all the cases were managed with a "poncho" flap approach to decrease exposure complication.
Geletu et al., 2022 **[25]**	A 1-year case report to present a surgical case with severe aesthetic bone atrophy after a deficient odontectomy.	A 27-year-old female patient with severe aesthetic bone atrophy after a deficient odontectomy. Based on the GBR clinical applications, the technique consists of bone reconstruction and a customized titanium mesh application.	Using mesh titanium in this case presentation was a reliable alternative to perform a lateral alveolar bone augmentation and reconstruct ridge deformities before reaching an ideal implant placement.	According to this case report, the customized titanium mesh could be a valuable option for guided bone regeneration in aesthetic maxillary defects.
Tallarico et al., 2020 **[26]**	A 1-year case report to present a clinical case of severe atrophy of the anterior maxilla in a younger female patient, treated with a titanium membrane customized with	A 19-year-old woman with a history of maxillary trauma was treated and followed-up for 1 year after implant placement. A narrow implant was inserted in a prosthetically driven position with the aid of computer-	The patient was followed up for 1 year after implant placement. Radiographs showed successful peri-implant bone remodeling and maintenance up to 1 year after implant placement.	Within the limitation of this case report a fully digital approach for the treatment of aesthetic, complex bone defects in the anterior maxilla may produce satisfactory results, and a proper learning curve, as

	computer-aided design/computer-aided manufacturing (CAD/CAM), simultaneous guided implant placement, and a fully digital workflow.	guided surgery. In the same surgical section, a customized implantable titanium mesh was applied. The scaffold was designed according to the contralateral maxillary outline in order to recreate a favorable maxillary bone volume. Finally, highly aesthetic, CAD/CAM, metal-free restorations were delivered using novel digital technologies.	well as well-trained team, is needed due to the seemingly extensive applications of new digital technologies.

Abbreviations: BBM, bovine bone mineral; BSM, bone substitute materials; CAD, computer-aided design; CAD /CAM, computer-aided design and manufacturing; CBR, custom bone regeneration; CT, computer tomography; GBR, guided bone regeneration; PBV, planned bone volume; PRF, platelet-rich fibrin; PTFE, polytetrafluoroethylene; RBV, regenerated bone volume; RR: regeneration rate; STL, stereolithographic model; VBG, vertical bone gain; VSP, virtual surgical plan.

Table S6. NHLBI Quality Assessment of Controlled Intervention Studies.

NHLBI Quality Assessment of Controlled Intervention Studies																
First Author et al., Year	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Q13**	**Q14**	**Total Score**	**Quality Rating**
Cucchi et al., 2021 **[12]**	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	11/14 (78.57%)	Good
Mounir et al., 2019 **[13]**	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	N	Y	Y	11/14 (78.57%)	Good

Q1: Was the study described as randomized, a randomized trial, a randomized clinical trial, or an RCT?, Q2: Was the method of randomization adequate (i.e., use of randomly generated assignment)?, Q3: Was the treatment allocation concealed (so that assignments could not be predicted)?, Q4: Were study participants and providers blinded to treatment group assignment?, Q5: Were the people assessing the outcomes blinded to the participants' group assignments?, Q6: Were the groups similar at baseline on important characteristics that could affect outcomes (e.g., demographics, risk factors, co-morbid conditions)?, Q7: Was the overall drop-out rate from the study at endpoint 20% or lower of the number allocated to treatment?, Q8: Was the differential drop-out rate (between treatment groups) at endpoint 15 percentage points or lower?, Q9: Was there high adherence to the intervention protocols for each treatment group?, Q10: Were other interventions avoided or similar in the groups (e.g., similar background treatments)?, Q11: Were outcomes assessed using valid and reliable measures, implemented consistently across all study participants?, Q12: Did the authors report that the sample size was sufficiently large to be able to detect a difference in the main outcome between groups with at least 80% power?, Q13: Were outcomes reported or subgroups analyzed prespecified (i.e., identified before analyses were conducted)?, Q14: Were all randomized participants analyzed in the group to which they were originally assigned, i.e., did they use an intention-to-treat analysis?; Total Score: Number of yes; CD: cannot be determined; NA: not applicable; NR: not reported; N: no; Y: yes. Quality Rating: Poor <50%, Fair 50–75%, Good ≥75%.

Table S7. NHLBI Quality Assessment for Before-After (Pre-Post) Studies with No Control Group.

NHLBI Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group														
First Author et al., Year	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Total Score**	**Quality Rating**
Cucchi et al., 2022 **[14]**	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y	N	9/12 (75,00%)	Good

Q1: Was the study question or objective clearly stated?, Q2: Were eligibility/selection criteria for the study population prespecified and clearly described?, Q3: Were the participants in the study representative of those who would be eligible for the test/service/intervention in the general or clinical population of interest?, Q4: Were all eligible participants that met the prespecified entry criteria enrolled?, Q5: Was the sample size sufficiently large to provide confidence in the findings?, Q6: Was the test/service/intervention clearly described and delivered consistently across the study population?, Q7: Were the outcome measures prespecified, clearly defined, valid, reliable, and assessed consistently across all study participants?, Q8: Were the people assessing the outcomes blinded to the participants' exposures/interventions?, Q9: Was the loss to follow-up after baseline 20% or less? Were those lost to follow-up accounted for in the analysis?, Q10: Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided p values for the pre-to-post changes?, Q11: Were outcome measures of interest taken multiple times before the intervention and multiple times after the intervention (i.e., did they use an interrupted time-series design)?, Q12: If the intervention was conducted at a group level (e.g., a whole hospital, a community, etc.) did the statistical analysis take into account the use of individual-level data to determine effects at the group level?; Total Score: Number of yes; CD: cannot be determined; NA: not applicable; NR: not reported; N: no; Y: yes. Quality Rating: Poor <50%, Fair 50–75%, Good ≥75%.

Table S8. NHLBI Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies.

	NHLBI Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies															
First Author et al., Year	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Q13**	**Q14**	**Total Score**	**Quality Rating**
Lizio et al., 2022 **[15]**	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y	N	11/14 (78.57%)	Good
Dellavia et al., 2021 **[16]**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	12/14 (85,71%)	Good
Ciocca et al., 2018 **[17]**	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	12/14 (85,71%)	Good
Chiapasco et al., 2021 **[18]**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	13/14 (92,85%)	Good
Navarro Cuéllar et al., 2021 **[19]**	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	12/14 (85,71%)	Good
Yang et al., 2022 **[20]**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	12/14 (85,71%)	Good

Q1: Was the research question or objective in this paper clearly stated?, Q2: Was the study population clearly specified and defined?, Q3: Was the participation rate of eligible persons at least 50%?, Q4: Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?, Q5: Was a sample size justification, power description, or variance and effect estimates provided?, Q6: For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?, Q7: Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?, Q8: For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?, Q9: Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?, Q10: Was the exposure(s) assessed more than once over time?, Q11: Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?, Q12: Were the outcome assessors blinded to the exposure status of participants?, Q13: Was loss to follow-up after baseline 20% or less?, Q14: Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?; Total Score: Number of yes; CD: cannot be determined; NA: not applicable; NR: not reported; N: no; Y: yes. Quality Rating: Poor <50%, Fair 50–75%, Good ≥75%.

Table S9. NHLBI Quality Assessment Tool for Case Series Studies/ Case report.

NHLBI Quality Assessment Tool for Case Series/Case Reports Studies											
First Author et al., Year	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Total Score**	**Quality Rating**
Ghanaati et al., 2019 **[21]**	Y	Y	Y	Y	Y	Y	Y	N	Y	8/9 (88,88%)	Good
Boogaard et al., 2019 **[22]**	Y	Y	N	Y	Y	Y	Y	N	Y	7/9 (77,78%)	Good
Nickenig et al., 2022 **[23]**	Y	Y	N	Y	Y	Y	Y	Y	Y	8/9 (88,88%)	Good
De Santis et al., 2022 **[24]**	Y	Y	N	Y	Y	Y	Y	Y	Y	8/9 (88,88%)	Good
Geletu et al., 2022 **[25]**	Y	Y	N	Y	Y	Y	N	N	Y	6/9 (66,67%)	Fair
Tallarico et al., 2020 **[26]**	Y	Y	N	Y	Y	Y	Y	N	Y	7/9 (77,78%)	Good

Q1: Was the study question or objective clearly stated?, Q2: Was the study population clearly and fully described, including a case definition?, Q3: Were the cases consecutive?, Q4: Were the subjects comparable?, Q5: Was the intervention clearly described?, Q6: Were the outcome measures clearly defined, valid, reliable, and implemented consistently across all study participants?, Q7: Was the length of follow-up adequate?, Q8: Were the statistical methods well-described?, Q9: Were the results well-described?; Total Score: Number of yes; CD: cannot be determined; NA: not applicable; NR: not reported; N: no; Y: yes. Quality Rating: Poor <50%, Fair 50–75%, Good > 75%

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