A Retrospective Evaluation of 192 Implants Placed in Augmented Bone: Long-Term Follow-Up Study

Mario Beretta, DDS, PhD[1]
Marco Cicciù, DDS, PhD, MSc[2]*
Pier Paolo Poli, DDS[1]
Davide Rancitelli, DDS, PhD[1]
Gianluca Bassi, DDS[1]
Giovanni Battista Grossi, MD, DDS[1]
Carlo Maiorana, MD, DDS[1]

The purpose of the present study was to assess the cumulative survival rate (CSR) of 192 implants placed in association with guided bone regeneration (GBR) procedures to evaluate the long-term predictability of this technique. Moreover, the Kaplan Meier survival analysis was applied to the data in order to evaluate predictors of implant failures, including the source of the graft, the type of membrane, and the timing of implant placement. The CSR of the sample was 95.6% over a mean follow-up period of 78 months (range, 1–175 months). Considering the source of graft, a 95.0%, 93.3%, and 97.7% CSR was obtained for demineralized bovine bone mineral (DBBM), autologous, and 1:1 ratio mixture of autologous and DBBM grafts,, respectively. The CSR referred to bioabsorbable membranes was 96.5%, whereas 94.6% was the CSR reported for nonresorbable membranes. The CSR of simultaneous surgeries was 96.8%, whereas staged surgeries showed a CSR of 94.5%. According to the data, implants placed in conjunction with GBR procedures presented a satisfying survival rate even in the long term. All the procedures performed with different bone grafts and type of membranes guaranteed optimal results both in one- and two-stage approaches. No statistically significant differences could be detected among the groups; indeed, the use of DBBM associated with resorbable membranes may be suggested to reduce patients' morbidity and treatment time. Therefore, the dental implants placed in association with bone regenerative procedures presented safe and predictable long-term clinical results.

Key Words: implants survival rate, guided bone regeneration, bone grafts, barrier membranes, dental implants

Downloaded from http://meridian.allenpress.com/joi/article-pdf/41/6/669/2039975/aaid-joi-d-14-00123.pdf by guest on 15 August 2024

Introduction

Alveolar ridge resorption following tooth loss may hamper an ideal prosthetic-driven implant placement. Additional bone augmentation procedures become mandatory in order to obtain adequate quality and quantity of hard and soft tissues for implant placement purposes.[1,2] The creation of a secluded anatomical site cannot be considered the only prerogative of barrier devices, particularly when guided bone regeneration (GBR) is performed. Thus, in addition to epithelial cell occlusivity, GBR exploits space maintenance and graft containment properties to promote newly bone formation underneath the membrane.[3] The present concept has been recently emphasized by the fact that although occlusive barriers have reported impressive outcomes, even porous membranes can lead to predictable bone regeneration with results equal or superior to those of occlusive membranes.[4–7] Particularly, macroporous titanium mesh allows proper blood supply to the graft and facilitates a greater bone regeneration compared with microporous membranes, contextually preventing significant soft tissue ingrowth.[8] A direct comparison between horizontal and vertical augmentation in terms of clinical outcome is difficult to perform due to heterogeneity of data among different studies; however, both techniques have demonstrated predictable results with comparable implant survival rates.[1,9,10] Briefly, Jensen and Terheyden[10] found a 100% median survival rate of implants placed in both horizontal and vertical dimensions, similar to those reported for pristine bone. In a recent systematic review concurring with the previously mentioned study, both horizontal and vertical GBR have proven to be effective and exhibit comparable implant survival rates.[1] The purpose of GBR shifts from increasing the availability of bone for proper implant placement to reconstructing hard and soft tissues similar to the prepathologic condition. Different protocols could be applied to GBR depending on the source of graft, the type of membrane, and the timing of the implant placement. Although autogenous bone represents the gold standard for ridge augmentation procedures due to osteogenic and osteoinductive properties, drawbacks have been reported, including donor-site morbidity, limited availability, and possible complications related to the harvesting procedure, such as neurosensory disturbances, prolonged healing, and opportunistic infections.[10,11] Limitations associated with the use of autografts have directed attention toward the use of bone substitutes.[12] So far, xenogenous bone alone or combined with

[1] Department of Dental Implants. UOC Maxillofacial Surgery and Odontostomatology, Fondazione IRCCS Cà Granda, University of Milan, Milan, Italy.
[2] Human Pathology Department, University of Messina, Messina, Italy.
* *Corresponding author,* e-mail: acromarco@yahoo.it
DOI: 10.1563/aaid-joi-D-14-00123

autologous bone, used in combination with either resorbable or nonresorbable membranes during GBR procedures, has shown encouraging results.[12–15] Several barrier devices have been developed to provide various functions in different clinical settings. The selection of a specific membrane is mainly dependent on biological and physical properties, which influence its function in relation to the anatomy of the bone defect and the required treatment; each material has inherent advantages and disadvantages.[5,16] Concerning GBR procedures, both bioabsorbable and nonresorbable membranes have demonstrated predictable results in terms of implant survival rate[13,17]; however, this type of surgery appears to be highly technique sensitive; therefore, the applicability to a wider array of operators and clinical settings remains unclear.[18] Lastly, the choice between simultaneous or delayed placement timing is mainly dictated by the residual bone amount. Indeed, the final goal of alveolar ridge reconstruction is the ideal implant insertion in a prosthetically driven position. If the native bone is sufficient for simultaneous implant placement, the observed advantages are mainly the reduction of treatment time and implant function as "tent screws" for the membrane in vertical regeneration. No clear evidence that the simultaneous or delayed implant placement may affect the implant survival rate in GBR procedures could be found in the literature; however, data concerning this aspect are still lacking.[19]

The aim of the present study was to assess the survival rate of dental implants placed in augmented bone to evaluate the predictability of GBR procedures in the long term. Moreover, a retrospective analysis was conducted to evaluate the influence of possible predictors of implant failure, including the source of bone grafts, the type of membranes, and the implant placement timing on the implant survival rate.

Materials and Methods

Study design

In the present retrospective cohort study, 61 patients with an age range of 25 to 79 years treated from 1999 to 2012 in the same clinical center (Department of Implantology, UOC Maxillo-facial Surgery and Odontostomatology Unit, Fondazione IRCCS Cà Granda Ospedale Maggiore Policlinico, University of Milan, Milan, Italy) were analyzed. The examiner was a postgraduate doctor in dental surgery (DDS) belonging to the aforementioned department who evaluated the sample of patients from May 2013 to September 2013 through a recalling program. To eliminate possible bias, the examiner was not directly involved in the procedures during patients' rehabilitations.

Inclusion criteria

Only patients who presented with partial edentulism and underwent localized horizontal or vertical alveolar ridge augmentation procedures with particulated grafts for implant rehabilitation purposes were admitted to the present study.

Exclusion criteria

Patients presenting poor oral hygiene, active periodontal infections, uncontrolled systemic pathologies, and presence of smoking habit (>10 cigarettes/day) were not treated with GBR procedures and therefore were not enrolled in the present study.

Clinical evaluation

During the clinical evaluation, only implants still present in the mouth (censored) at the end of the observation period, with no signs of mobility, peri-implantitis, and symptoms such as pain and/or altered sensation were considered survived.[6,19] For each patient, a record containing the source of the graft (autologous, xenogenous, or a mixture of autologous and xenogenous), the type of membrane (bioabsorbable or nonresorbable), the timing of implant insertion (simultaneous or delayed), and the date of implant loss was completed.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (version 21.0, SPSS Inc, Chicago, Ill). Kaplan-Meier survival analyses were done for the complete group of implants and discriminated according to type of grafting materials, membranes used, and timing of implant placement. Log rank tests were utilized to compare the survival rate for implants in each of the subgroups. P values $<$ .05 were considered statistically significant.

Results

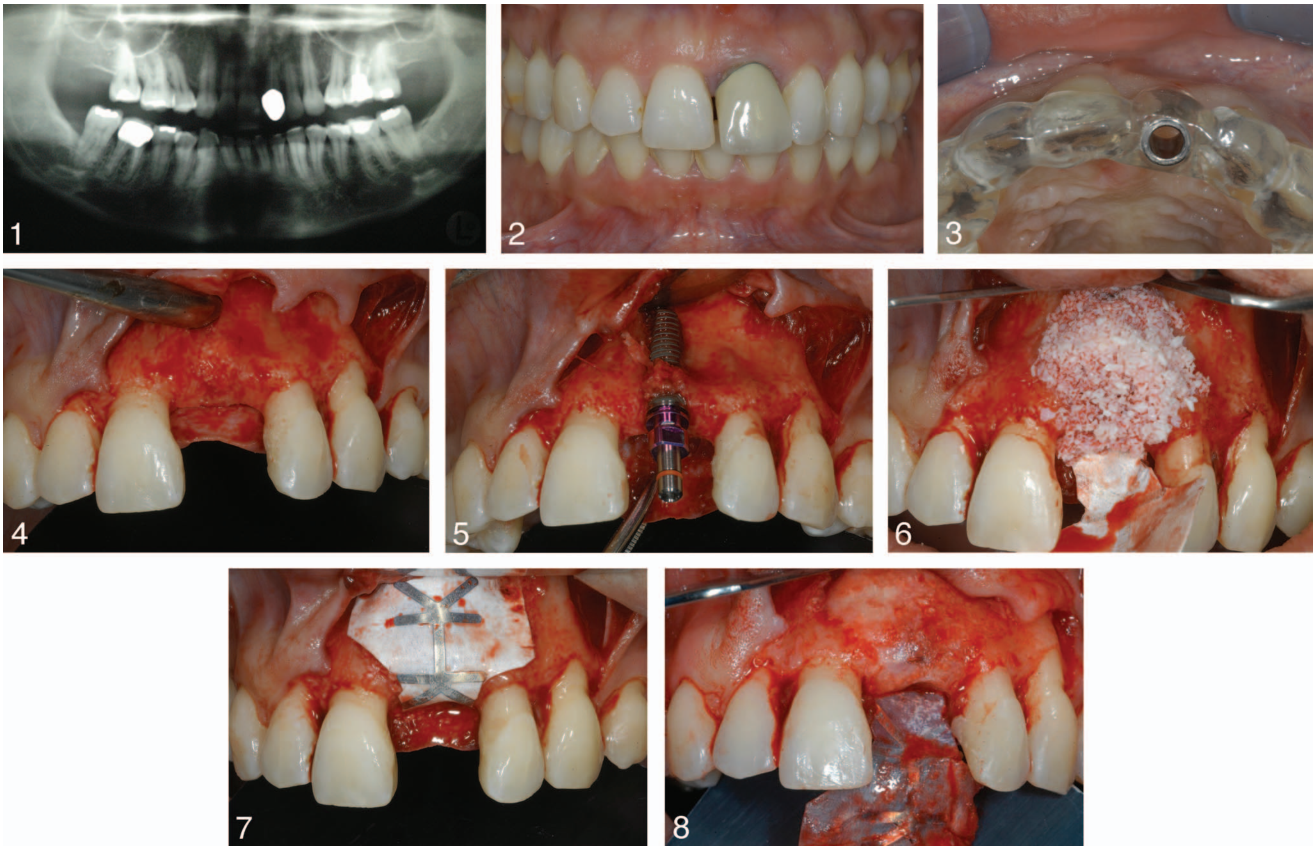
A total of 192 implants inserted in 37 female and 24 male patients were retrospectively evaluated. Of these, 76 implants were placed in particulated demineralized bovine bone mineral (DBBM) graft (Bio-Oss, Geistlich Pharm AG, Wolhausen, Switzerland), 20 in particulated autogenous bone graft, and 96 into a 1:1 ratio mixture of autologous and DBBM particulated graft. Furthermore, of the grafted sites, 101 were covered with resorbable membranes (Bio-gide; Geistlich Pharm AG) and 91 were protected with nonresorbable expanded polytetrafluoroethylene membranes (Gore-Tex, W.L. Gore & Associates, Flagstaff, Ariz). Regarding timing, 95 implants were positioned simultaneously with the GBR surgery, and 97 implants were inserted according to a delayed approach 6 months after the surgery (Figures 1 through 10).

Among the 192 implants positioned, 5 implant failures occurred. Over a median follow-up period of 78 months (range, 1175 months) the cumulative survival rate (CSR) was 95.6% (Figure 11). In regard to the source of the bone graft, 2 failures occurred in the DBBM group, and a CSR of 95.0% was reported. One failure occurred in the autogenous group, showing a CSR of 93.3%. Two implants failed in the mixed group, leading to a CSR of 97.7% (Figure 12).

Considering the type of membrane, the CSR was 96.5% when the surgical sites were covered with bioabsorbable membranes, whereas a CSR of 94.6% was reported when the graft was protected with nonresorbable membranes (Figure 13).

With respect to the surgical approach, 2 implant failures occurred after one-stage procedures, and 3 implants failed after the two-stage approach. A CSR of 96.8% was found in the

Downloaded from http://meridian.allenpress.com/joi/article-pdf/41/6/669/2039975/aaid-joi-d-14-00123.pdf by guest on 15 August 2024



Figures 1–8. Figure 1. Radiographic investigation underlining apical lesion at the left upper central incisor. **Figure 2.** Clinical preoperative evaluation of central upper incisor. **Figure 3.** Surgical guided device for placing dental implant in the ideal prosthetic position. **Figure 4.** Bone defects underlined after the flap opening. **Figure 5.** Dental implant positioning following the ideal prosthetic position. Horizontal and vertical bone defects can be easily seen. **Figure 6.** Bone regeneration by using a mixture of autologous bone and deproteinized bovine bone is applied on the defect. **Figure 7.** Expanded polytetrafluoroethylene reinforced on titanium has been applied for doing guided bone regeneration technique. **Figure 8.** Six months after the first surgery; the second surgery for removing the membrane shows the consistency of the new bone volume.

simultaneous approach, and a CSR of 94.5% was reported in the delayed approach (Figure 14).

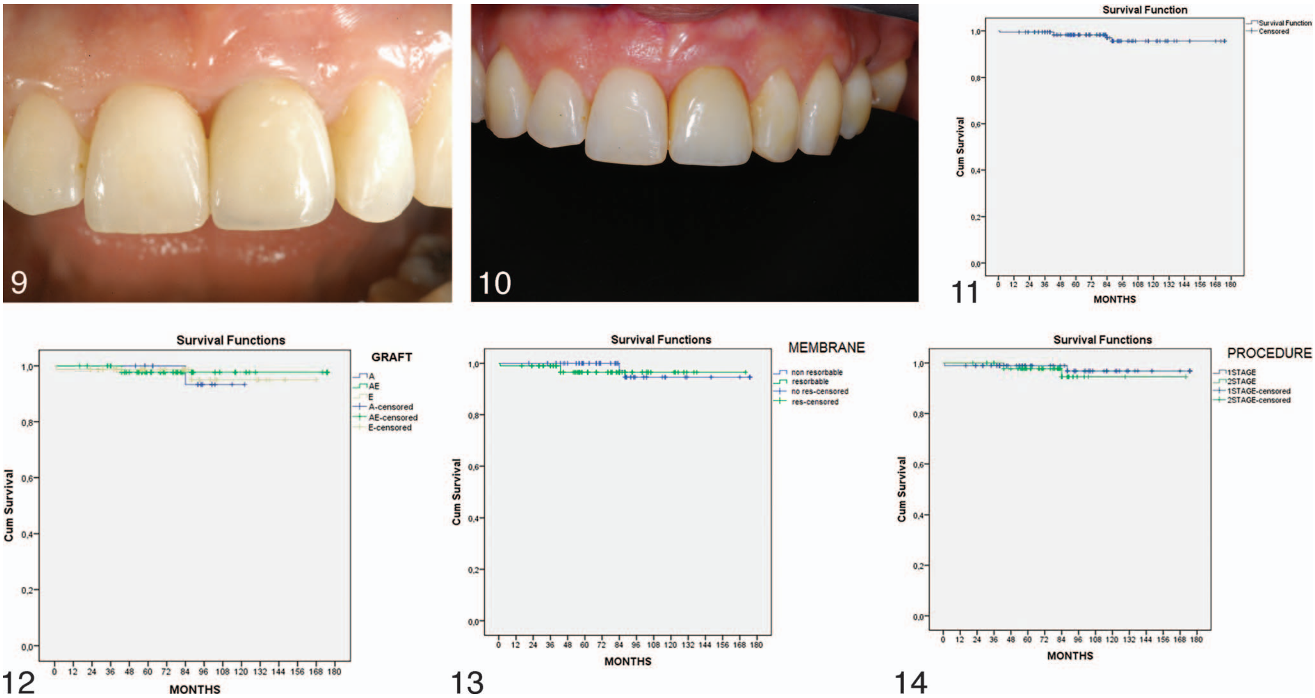
No log rank statistically significant differences ($P > .05$) were found among source of graft, type of membrane, and implant placement timing variable groups (Table).

Discussion

The purpose of the present study was to assess the CSR of 192 implants placed in association with GBR procedures and to evaluate the influence of source of graft, type of membrane, and timing of the surgical procedure on the results. A CSR of 95.6% over a mean follow-up of 78 months was calculated. This was in accordance with the principal studies currently available in the literature.[20–22] In a recent review by Clementini et al[23] that took into consideration the CSR of implants inserted in alveolar ridges augmented with GBR procedures, a range from 93.7% to 100% was noticed in all of the analyzed studies, with a follow-up ranging between 1 and 7 years. It was therefore assumed that GBR could be a predictable technique for implant placement purposes in atrophic sites.[23] A further review by Simion et al.[15] reported a CSR concerning vertical GBR ranging from 92.1% and 100%, up to a 7-year follow-up period. Konstantinidis et al[6] found a CSR of 97.3% with implants placed in resorbed ridges using a simultaneous GBR procedure 1 year after loading independently from the membrane adopted. Similarly, in a recent article, Bazrafshan and Darby[24]observed a cumulative survival rate of 97.5% evaluating 59 implants with a mean follow-up of 35 months.

Regarding the estimated CSR of implants inserted in regenerated sites depending on the type of bone grafts, independent of the type of barrier membrane, a CSR of 97.7% was achieved with autologous and DBBM grafts mixed together, 95.0% when a DBBM graft alone was chosen, and 93.3% when only autologous bone was preferred. Several studies revealed a CSR ranging from 92.6% to 100% concerning implants placed in sites regenerated with xenografts or autografts used alone or mixed together.[25] Chiapasco and Zaniboni,[26] in a systematic literature review, investigated studies in which GBR procedures were applied to correct peri-implant defects. From the research, 5 prospective[25,27–30] and 2 retrospective studies[31,32] were included. A total of 238 patients received 374 implants placed in conjunction with different type of grafts and membranes. The overall survival rate was 95.7% with a minimum value of 84.7% and a maximum

Downloaded from http://meridian.allenpress.com/joi/article-pdf/41/6/669/2039975/aaid-joi-d-14-00123.pdf by guest on 15 August 2024



Figures 9–14. Figure 9. Final crown restoration. **Figure 10.** Three years follow-up clinical control. **Figure 11.** Survival rate. **Figure 12.** Survival rate considering grafts. **Figure 13.** Survival rate considering membranes. **Figure 14.** Survival rate considering procedures.

value of 100%, after at least 1 year of follow-up. It could be assumed, as confirmed by other studies[15,33,34] that xenogenic and autologous grafts mixed together provided better results in terms of newly formed bone amount, probably due to the fact that the intrinsic osteoconductive properties belonging to the DBBM could reduce the physiological bone resorption induced by the natural remodeling.[15,34] Even if the present data were not statistically significant, the 1:1 ratio autogenous/DBBM mixture offered slightly superior outcomes when CSRs were compared. Because of the intrinsic proprieties of both materials, in case of a simultaneous approach only a limited amount of autogenous particles facing the implant surface toward the dehiscence may be needed, as DBBM characterized by a slow substitution time could be employed to cover and protect the autograft during the remodeling phase.

Relating the CSR with the type of membrane, disregarding the type of bone graft and the timing of implant placement, a CSR of 96.5% was observed for bioabsorbable membranes, while a CSR of 94.6% was noticed for nonresorbable membranes. Zitzmann et al,[25] analyzing 41 implants treated with nonresorbable membranes, found a CSR of 92.6% after a mean follow-up of 5 years; contextually, a total of 112 implants placed in conjunction with resorbable membranes showed a 95.4% CSR. Blanco et al,[27] considering 26 implants presenting fenestrations or dehiscences managed with nonresorbable membranes, achieved a CSR of 96.1% over a 5-year follow-up period. Finally, Jung et al,[17] evaluating 153 implants placed in combination with GBR techniques, reported a CSR of 91.9% for bioabsorbable membranes and 92.6% for nonresorbable membranes, with a mean follow-up of 12.5 years. Considering the type of membrane, nonstatistically significant superior outcomes were found when bioabsorbable barriers were considered. The employment of resorbable or nonresorbable membranes was clinically dictated by the criticism of the bony defect. The current orientation of the authors was to extend the use of collagen barriers even in wide defects. Indeed, in authors' opinion, fixing and tightening bioabsorbable membranes with bone pins may prevent early dislocation of the barrier, thereby increasing the stability of the graft and the conservation of the desired bone volume with results comparable to those reported for nonresorbable membranes.

Table 1

Significant *P* values for each recorded group

Groups	*P* Value
Graft (autograft/xenograft in a 1:1 mixture)	.93
Membrane (resorbable/not resorbable)	.65
Surgical approach (1 stage/2 stage)	.52

Regarding the timing of implant placement, without considering the type of graft and membrane used, a CSR of 96.8% emerged from 1-stage procedures, whereas a rate of 94.5% was observed in case of a delayed approach. Similarly, Milinkovic and Cordaro[1] reported a mean implant survival rate of 98.9% and 100% when simultaneous and staged GBR were assessed, respectively. Zitzmann et al[25] revealed a CSR in regenerated sites with a 1-stage procedure in conjunction with bioabsorbable membranes of 95.4%, while a CSR of 92.6% was found when nonresorbable membranes were used. High survival rates ranging from 91.9% to 92.6% were also reported by Jung et al,[17] in a study of 265 implants placed simultaneously with GBR procedures using resorbable or nonresorbable membranes. A cumulative survival rate of 97.2% after 12

Downloaded from http://meridian.allenpress.com/joi/article-pdf/41/6/669/2039975/aaid-joi-d-14-00123.pdf by guest on 15 August 2024

months of loading was reported by Konstantinidis et al[6] in an evaluation of 36 implants placed simultaneously with GBR surgeries. With respect to staged GBR, survival rates of 99% to 100% were reported for observation periods ranging from 22.4 months to 5 years after loading.[19] Data from the literature emphasized the relevant reduction of possible implant failures when a 2-stage approach was considered.[35] The grafted bone may spontaneously heal over a sufficient period of time without being altered by external events or possible interferences caused by the presence of implants. During an adequate healing time, a remodeling process occurs, resulting in incorporated mineralized bone, which enhances the osteointegration percentage of the implants at the recipient site. Furthermore, the staged approach could represent a suitable alternative, especially in case of severely atrophic bone defects, because during the second surgery, clinicians would be able to evaluate the reconstruction obtained and eventually perform a further regenerative procedure. As the results reported in our study were not statistically different, there was no evidence to affirm whether the simultaneous or the staged approach may be considered the gold standard to obtain the most predictable amount of regenerated bone associated with GBR. Since the 1-stage protocol obtained comparable results in terms of implant CSR, simultaneous surgery should be suggested when the native bone is adequate to place implants in the correct position. Consequently, the number of surgeries and the time needed to finalize the rehabilitation could be reduced to a minimum.

Conclusions

According to the survival rate analysis conducted in the present study, implants placed in conjunction with GBR procedures presented encouraging results, even in the long term. A statistically significant difference comparing each predictor of implant failures could not be found. The use of DBBM combined with resorbable membranes may avoid the harvesting procedure and the reentry surgery, thereby reducing postoperative morbidity for the patient and the treatment time. Further long-term studies will be necessary to widen the potential of DBBM and resorbable membranes in the reconstruction of extended bone defects simultaneously with implant placement.

Abbreviations

CSR: cumulative survival rate
DBBM: demineralized bovine bone mineral
GBR: guided bone regeneration

References

1. Milinkovic I, Cordaro L. Are there specific indications for the different alveolar bone augmentation procedures for implant placement? A systematic review. *Int J Oral Maxillofac Surg*. 2014;43:606–625.
2. Dahlin C, Linde A, Gottlow J, Nyman S. Healing of bone defects by guided tissue regeneration. *Plast Reconstr Surg*. 1988;81:672–676.
3. Retzepi M, Donos N. Guided bone regeneration: biological principle and therapeutic applications. *Clin Oral Implants Res*. 2010;21:567–576.
4. Her S, Kang T, Fien MJ. Titanium mesh as an alternative to a membrane for ridge augmentation. *J Oral Maxillofac Surg*. 2012;70:803–810.
5. Rakhmatia YD, Ayukawa Y, Furuhashi A, Koyano K. Current barrier membranes: titanium mesh and other membranes for guided bone regeneration in dental applications. *J Prosthodont Res*. 2013;57:3–14.
6. Konstantinidis I, Kumar T, Kher U, Stanitsas PD, Hinrichs JE, Kotsakis GA. Clinical results of implant placement in resorbed ridges using simultaneous guided bone regeneration: a multicenter case series. *Clin Oral Investig*. 2015;19:553–559.
7. Rasia-Dal Polo M, Poli PP, Rancitelli D, Beretta M, Maiorana C. Alveolar ridge reconstruction with titanium meshes: a systematic review of the literature. *Med Oral Patol Oral Cir Bucal*. 2014;19:e639–e646.
8. Gutta R, Baker RA, Bartolucci AA, Louis PJ. Barrier membranes used for ridge augmentation: is there an optimal pore size? *J Oral Maxillofac Surg*. 2009;67:1218–1225.
9. Annibali S, Bignozzi I, Sammartino G, La Monaca G, Cristalli MP. Horizontal and vertical ridge augmentation in localized alveolar deficient sites: a retrospective case series. *Implant Dent*. 2012;21:175–185.
10. Jensen SS, Terheyden H. Bone augmentation procedures in localized defects in the alveolar ridge: clinical results with different bone grafts and bone-substitute materials. *Int J Oral Maxillofac Implants*. 2009; 24(suppl):218–236.
11. McAllister BS, Haghighat K. Bone augmentation techniques. *J Periodontol*. 2007;78:377–396.
12. Hammerle CH, Jung RE, Yaman D, Lang NP. Ridge augmentation by applying bioresorbable membranes and deproteinized bovine bone mineral: a report of twelve consecutive cases. *Clin Oral Implants Res*. 2008;19:19–25.
13. Carpio L, Loza J, Lynch S, Genco R. Guided bone regeneration around endosseous implants with anorganic bovine bone mineral. A randomized controlled trial comparing bioabsorbable versus non-resorbable barriers. *J Periodontol*. 2000;71:1743–179.
14. Hammerle CH, Chiantella GC, Karring T, Lang NP. The effect of a deproteinized bovine bone mineral on bone regeneration around titanium dental implants. *Clin Oral Implants Res*. 1998;9:151–162.
15. Simion M, Fontana F, Rasperini G, Maiorana C. Vertical ridge augmentation by expanded-polytetrafluoroethylene membrane and a combination of intraoral autogenous bone graft and deproteinized anorganic bovine bone (Bio Oss). *Clin Oral Implants Res*. 2007;18:620–629.
16. Garg A. Barrier membranes—materials review, Part I of II. *Dent Implantol Update*. 2011;22:61–64.
17. Jung RE, Fenner N, Hammerle CH, Zitzmann NU. Long-term outcome of implants placed with guided bone regeneration (GBR) using resorbable and non-resorbable membranes after 12-14 years. *Clin Oral Implants Res*. 2013;24:1065–1073.
18. Rocchietta I, Fontana F, Simion M. Clinical outcomes of vertical bone augmentation to enable dental implant placement: a systematic review. J Clin Periodontol. 2008;35(8 suppl):203–215.
19. Donos N, Mardas N, Chadha V. Clinical outcomes of implants following lateral bone augmentation: systematic assessment of available options (barrier membranes, bone grafts, split osteotomy). *J Clin Periodontol*. 2008;35(suppl):173–202.
20. Simion M, Jovanovic SA, Tinti C, Benfenati SP. Long-term evaluation of osseointegrated implants inserted at the time or after vertical ridge augmentation. A retrospective study on 123 implants with 1-5 year follow-up. *Clin Oral Implants Res*. 2001;12:35–45.
21. Chiapasco M, Romeo E, Casentini P, Rimondini L. Alveolar distraction osteogenesis vs. vertical guided bone regeneration for the correction of vertically deficient edentulous ridges: a 1-3-year prospective study on humans. *Clin Oral Implants Res*. 2004;15:82–95.
22. Llambes F, Silvestre FJ, Caffesse R. Vertical guided bone regeneration with bioabsorbable barriers. *J Periodontol*. 2007;78:2036–2042.
23. Clementini M, Morlupi A, Canullo L, Agrestini C, Barlattani A. Success rate of dental implants inserted in horizontal and vertical guided bone regenerated areas: a systematic review. *Int J Oral Maxillofac Surg*. 2012; 41:847–852.
24. Bazrafshan N, Darby I. Retrospective success and survival rates of dental implants placed with simultaneous bone augmentation in partially edentulous patients. *Clin Oral Implants Res*. 2014;25:768–773.
25. Zitzmann NU, Scharer P, Marinello CP. Long-term results of implants treated with guided bone regeneration: a 5-year prospective study. *Int J Oral Maxillofac Implants*. 2001;16:355–366.
26. Chiapasco M, Zaniboni M. Clinical outcomes of GBR procedures to correct peri-implant dehiscences and fenestrations: a systematic review. *Clin Oral Implants Res*. 2009;20(suppl 4):113–123.

Downloaded from http://meridian.allenpress.com/joi/article-pdf/41/6/669/2039975/aaid-joi-d-14-00123.pdf by guest on 15 August 2024

27. Blanco J, Alonso A, Sanz M. Long-term results and survival rate of implants treated with guided bone regeneration: a 5-year case series prospective study. *Clin Oral Implants Res*. 2005;16:294–301.

28. Dahlin C, Lekholm U, Becker W, et al. Treatment of fenestration and dehiscence bone defects around oral implants using the guided tissue regeneration technique: a prospective multicenter study. *Int J Oral Maxillofac Implants*. 1995;10:312–318.

29. Christensen DK, Karoussis IK, Joss A, Hammerle CH, Lang NP. Simultaneous or staged installation with guided bone augmentation of transmucosal titanium implants. A 3-year prospective cohort study. *Clin Oral Implants Res*. 2003;14:680–686.

30. De Boever AL, De Boever JA. Guided bone regeneration around non-submerged implants in narrow alveolar ridges: a prospective long-term clinical study. *Clin Oral Implants Res*. 2005;16:549–556.

31. Lorenzoni M, Pertl C, Polansky RA, Jakse N, Wegscheider WA. Evaluation of implants placed with barrier membranes. A restrospective follow-up study up to five years. *Clin Oral Implants Res*. 2002;13:274–280.

32. Juodzbalys G, Raustia AM, Kubilius R. A 5-year follow-up study on one-stage implants inserted concomitantly with localized alveolar ridge augmentation. *J Oral Rehabil*. 2007;34:781–789.

33. Fabbri G, Brennan M, Manfredi M, Ban G. Guided bone regeneration technique in the esthetic zone: a novel approach using resorbable PLLA-PGA plates and screw fixation. A case report. *Int J Periodontics Restorative Dent*. 2009;29:543–547.

34. Maiorana C, Beretta M, Battista Grossi G, et al. Histomorphometric evaluation of anorganic bovine bone coverage to reduce autogenous grafts resorption: preliminary results. *Open Dent J*. 2011;5:71–78.

35. Lundgren S, Sjostrom M, Nystrom E, Sennerby L. Strategies in reconstruction of the atrophic maxilla with autogenous bone grafts and endosseous implants. *Periodontol 2000*. 2008;47:143–161.

Downloaded from http://meridian.allenpress.com/joi/article-pdf/41/6/669/2039975/aaid-joi-d-14-00123.pdf by guest on 15 August 2024