Peri-implant Tissues and Patient Satisfaction After Treatment of Vertically Augmented Atrophic Posterior Mandibles with Intraoral Onlay Block Bone Grafts: A Retrospective 3-Year Case Series Follow-up Study

Amparo Aloy-Prósper, DDS, PhD[1]/David Peñarrocha-Oltra, DDS, MSc, PhD[2]/
Maria Peñarrocha-Diago, DDS, PhD[3]/Federico Hernández-Alfaro, MD, DDS, PhD[4]/
Miguel Peñarrocha-Diago, MD, PhD[5]

Purpose: *To evaluate the peri-implant soft and hard tissues of dental implants placed in vertically regenerated posterior mandibles with intraoral onlay block bone grafts and patient satisfaction at 3-year follow-up.* ***Materials and Methods:*** *A retrospective study of patients with dental implants placed in posterior mandibular sites vertically augmented with intraoral onlay block bone grafts was carried out between 2005 and 2009 at the University of Valencia. The outcomes assessed at the 3-year follow-up visit were the peri-implant soft tissues (Plaque Index and Bleeding Index, probing depth, keratinized mucosa width, and recession), implant survival and success rates, marginal bone loss, and patient satisfaction.* ***Results:*** *Sixteen patients with 36 implants were included. The mean Plaque Index and Bleeding Index scores were ≤ 0.4. The mean band of facial keratinized mucosa was ≥ 3 mm in 52.7% of implants; 38.8% of the implants showed facial recession. The mean midfacial recession was –0.31 ± 0.75 mm. Implant survival reached 100%, while the success rate was 85%, and the mean marginal bone loss was 1 ± 1.03 mm (range: 0.1 to 5.3). Good quality of life (9.19 ± 0.40) was reported for all patients, and the overall general satisfaction score was 8.07 ± 1.04 (mucosa esthetics: 7.71 ± 1.45; prosthesis esthetics: 8.42 ± 0.6; chewing: 8.68 ± 0.94; ease of cleaning: 8.01 ± 1.03).* ***Conclusion:*** *Considering the limitations of the study, implants in vertically augmented posterior mandibular areas with intraoral onlay block bone grafts showed good soft tissue levels and high patient satisfaction. No implants were lost at 3 years postloading, though one-fifth of the patients showed a statistically significant marginal bone loss.* Int J Oral Maxillofac Implants 2018;33:137–144. doi: 10.11607/jomi.4490

Keywords: *atrophied mandible, block bone graft, intraoral graft, onlay graft, soft tissues, vertical augmentation*

[1]Assistant Professor of Oral Surgery, Stomatology Department, Faculty of Medicine and Dentistry, University of Valencia, Valencia, Spain.
[2]Collaborating Professor of the Master in Oral Surgery and Implant Dentistry, Stomatology Department, Faculty of Medicine and Dentistry, University of Valencia, Valencia, Spain.
[3]Full Professor of Oral Surgery, Stomatology Department, Faculty of Medicine and Dentistry, University of Valencia, Valencia, Spain.
[4]Chairman of Oral Maxillofacial Surgery Department, Catalonia International University, Barcelona, Spain.
[5]Chairman of Oral Surgery, Stomatology Department, Faculty of Medicine and Dentistry, University of Valencia, Valencia, Spain.

Correspondence to: Dr Miguel Peñarrocha-Diago, Clínicas Odontológicas, Gascó Oliag 1, 46021 – Valencia, Spain. Fax: +34-96-3864139. Email: miguel.penarrocha@uv.es

©2018 by Quintessence Publishing Co Inc.

The treatment of vertical atrophy of the posterior areas of the mandible with dental implants remains a strong challenge for clinicians due to the limited bone above the mandibular canal.[1,2] Several augmentation techniques have been proposed, such as guided bone regeneration, vertical alveolar distraction, and block bone grafts.[3,4]

Bone grafting techniques are related to an unpredictable degree of resorption of the volume achieved with the grafted material, especially in vertical augmentation.[1,5] Such resorption may significantly impair the esthetic outcome of the procedure[6,7] as well as peri-implant hard tissues.[8] There is little evidence on bone graft volume maintenance over time, though several authors have reported that resorption ends with the dental implant placement, due to the functional loading effect.[9,10]

© 2018 BY QUINTESSENCE PUBLISHING CO, INC. PRINTING OF THIS DOCUMENT IS RESTRICTED TO PERSONAL USE ONLY.
NO PART MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM WITHOUT WRITTEN PERMISSION FROM THE PUBLISHER.

However, despite implants remaining osseointegrated and stable over time, a varying degree of vertical resorption has been observed around the peri-implant bone.[8,11] The stability of peri-implant bone is one of the most paramount factors affecting long-term implant survival and success rates.[8] In this regard, a discrepancy in marginal bone level has been found[12]; Chiapasco et al[13] reported 1.3 mm at 4 years (mandibular ramus) while Levin et al[14] reported 0.22 mm, ranging from 0 to 3.3 mm at 2 years (intraoral graft). Systematic literature reviews involving implants placed in atrophic ridges vertically augmented with intraoral block onlay bone grafts found implant survival rates that ranged from 76% to 100%, and success rates from 89.5% to 100%.[3,4,14,15] Nevertheless, obtaining osseointegration should not be an exclusive criterion for considering the success of dental implant therapy.[16] Peri-implant soft tissue appearance has been reported as a decisive factor in the success of implant treatment.[16,17] Nevertheless, in posterior mandibular regions, esthetics may not be useful, and other aspects must be considered, such as the chewing functional aspect and ease of cleaning.[18–22] To date, no studies assessing these outcomes in posterior mandibular regions augmented with bone grafts have been found. Although block augmentation procedures are common in dental implant procedures, there is little evidence about how the increased tissues behave in the medium or long term, changes in the resulting peri-implant soft tissues, and patient satisfaction. To provide evidence on the clinical efficacy and esthetic results of dental implant therapy with block bone graft procedures, it is necessary to evaluate the peri-implant tissue health.[7]

The purpose of this study was to evaluate the peri-implant soft and hard tissue conditions of dental implants placed in vertically augmented posterior mandibles with intraoral onlay block bone grafts and patient satisfaction at 3-year follow-up.

MATERIALS AND METHODS

Patient Screening

A retrospective clinical study was conducted in patients who required vertical augmentation in the posterior mandibular edentulous region (7 to 8 mm of bone above the mandibular canal) and were treated with intraoral onlay block bone grafts and delayed dental implants between 2005 and 2009 in the Oral Surgery Department of the University of Valencia (Valencia, Spain). The study complied with the Declaration of Helsinki on human research. Patients were informed about the study and signed an informed consent form. The study conformed to the STROBE statement.[23] The study design was approved by the University of Valencia ethical board (Ref.: H1407338004921). The patient sample was from a previously published case series.[24] Patients aged > 18 years, rehabilitated with implant-supported prostheses (single or partial denture), with no relevant medical conditions, nonsmokers or smokers of ≤ 20 cigarettes/day, and with a minimum follow-up of 3 years postloading were included in the present study. Pregnant patients, patients with poor oral hygiene, and patients who did not attend control visits were excluded from the study. The same practiced oral surgeon performed all surgical procedures (M.P.D).

Treatment Procedures

The treatment procedures were detailed elsewhere.[24] The ultrasonic Piezon Master Surgery System (EMS Electromedical Systems) was used to obtain all grafts. Implants with the TSA Avantblast surface (Phibo Dental Solutions S.L.) were placed.

Data Collection and Follow-up

All patients were enrolled in a maintenance program that included routine check-ups and professional prophylaxis every 6 months. A trained single clinician different from the surgeon or the prosthodontist collected all data using a pre-established protocol (A.A.P.)[24] Patient age (at implant placement), sex, brushing habits (≥ 3 times/day; 1 to 2 times/day), smoking habits (no; < 10 cigarettes/day; 10 to 20 cigarettes/day), donor site (symphysis/ramus), implant size (length and diameter), and prostheses design (single/partial denture/cemented/screwed) were registered.

The following parameters were evaluated at the 3-year follow-up visit.

Peri-implant Soft Tissue Health. Plaque Index (PI) and Bleeding Index (BI) were recorded according to Mombelli et al.[25] Probing depth (PD) in millimeters was assessed in the mesial, midfacial, distal, and lingual aspects. The width of the keratinized mucosa (WKM) and facial mucosal recession (in a direction parallel to the long axis from the highest point in the midfacial soft tissue margin to around the implant-supported restoration) were measured with a millimetered periodontal probe (Hu-Friedy UNC).[26] Peri-implant diseases were defined according to the Consensus Report of the VI European Workshop on Periodontology[27] as peri-implant mucositis when implants showed mucosal redness, swelling, and bleeding on probing, without radiographic bone loss; and as peri-implantitis when implants showed in addition to the aforementioned inflammatory signs and/or increased probing depth and/or suppuration, radiographic bone loss.

Implant Survival. Implant survival was the percentage of implants that were in place at the end of the follow-up.

Implant Success. The criteria for success were based on the predefined criteria proposed by Buser et al: ab-

© 2018 BY QUINTESSENCE PUBLISHING CO, INC. PRINTING OF THIS DOCUMENT IS RESTRICTED TO PERSONAL USE ONLY.
NO PART MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM WITHOUT WRITTEN PERMISSION FROM THE PUBLISHER.

sence of clinical symptoms such as implant mobility, pain, and absence of any peri-implant radiolucency.[28]

Marginal Bone Loss. Intraoral radiographs were obtained with an XMIND intraoral system (Groupe Satelec-Pierre Rolland) and an RVG intraoral digital receptor (Dürr Dental) with the aid of Rinn XCP (Dentsply Rinn). Measurements were made of peri-implant marginal bone levels at prosthetic loading (baseline) and at the 3-year follow-up visit and calibrated using the CliniView software (version 5.1, Instrumentarium Imaging). The difference from the change in bone level between the baseline and 3-year follow-up measured from the implant-abutment connection to the nearest 0.5 mm mesial and distal peri-implant marginal bone level was used to calculate bone loss. Before assessing the entire implant sample, intraexaminer calibration was analyzed over a total of 30 random sites (random function of Microsoft Excel 2010) performed on different days. The intraclass correlation coefficient was 0.876, showing high concordance between the two sets of data. A 0.053-mm error was estimated according to Dahlberg's d value.[29]

Patient Satisfaction and Quality of Life. A self-administered questionnaire was given to rate the overall satisfaction with the treatment. Patients were asked about quality of life, esthetic, mastication, chewing comfort, phonetics, ease of cleaning, and predisposition to undergo the same procedure again. A visual analog scale (VAS range 1 to 10) was used.

Statistical Analysis

Bivariate correlation using the Spearman test was performed to evaluate whether the probing depth, mucosal recession, and marginal bone loss were related to WKM. The relationship between the presence of recession (yes/no) and implant failure, biotype, donor site, and sex was analyzed using the Fisher exact test. To determine the relationship between the presence of recession (yes/no) and the WKM and the patient's age, the Mann-Whitney test was calculated. To assess the mean of patient satisfaction and age, the Spearman test was performed; to relate this variable with sex and the presence of mucosal recession, the Mann-Whitney test was used.

Statistical analysis with SPSS version 15.0 (SPSS) by a biostatistician with experience in the field of dentistry that acted as "blind" was performed.

RESULTS

The initial sample comprised 20 patients,[24] but four were excluded for not attending follow-up visits. Accordingly, the final sample included 16 patients (10 women, 6 men) with a mean age of 47.5 ± 11.9 years (range: 21 to 61 years). Descriptive patient data are shown in Table 1.

Table 1 Descriptive Patient Data

Variable	No. patients
Sex	6 men, 10 women
Age (y)	47.5 ± 11.9 (21–61)
Frequency of toothbrushing	
≥ 3 times/day	11
1–2 times/day	5
Smoking	
Yes < 10 cigarettes a day	3
No	13
Biotype	
Thin	10
Thick	6
Prostheses	
Cemented	8
Screwed	8

Implant Survival and Success Rates and Radiographic Peri-implant Marginal Bone Loss

At 3 years postloading, no implant was removed, but nine implants, in three patients, showed a statistically significant marginal bone loss (mean: 2.02 ± 1.44 mm) and were considered as a failure. Implant survival was 100%, and the success rate was 85%. The mean marginal bone loss at 3 years after loading was 1 ± 1.03 mm (range: 0.1 to 5.3 mm) (Figs 1 to 3).

No statistically significant relationships were found between mean bone loss and age (P = .709), sex (P = .153), frequency of brushing (P = .814), smoking (P = .132), donor site (P = .519), and dental implant length (P = .722) or diameter (P = .746).

Peri-implant Soft Tissue Parameters

Descriptive data are presented in Table 2. Statistically significant differences were found between WKM and buccal probing depth (P = .04), recession (P < .001), and bone loss (P = .023), with a tendency toward significance in the case of implant failure (P = .056). Statistically significant differences were found between recession and keratinized mucosa (P < .001), implant failure (P = .047), and age (P = .047), but not biotype, donor site location, or sex.

Regarding the implants considered to have failed (nine implants), mean PI and modified BI were 0.2 ± 0.63 and 1.3 ± 1.41, respectively. The mean probing depth was 4.2 ± 1.31 mm in buccal, and 3.5 ± 1.02 mm in lingual; these implants showed a statistically significantly higher probing depth than implants with healthy hard tissues (P < .001). Facial recessions were found in 44.4%

© 2018 BY QUINTESSENCE PUBLISHING CO, INC. PRINTING OF THIS DOCUMENT IS RESTRICTED TO PERSONAL USE ONLY.
NO PART MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM WITHOUT WRITTEN PERMISSION FROM THE PUBLISHER.

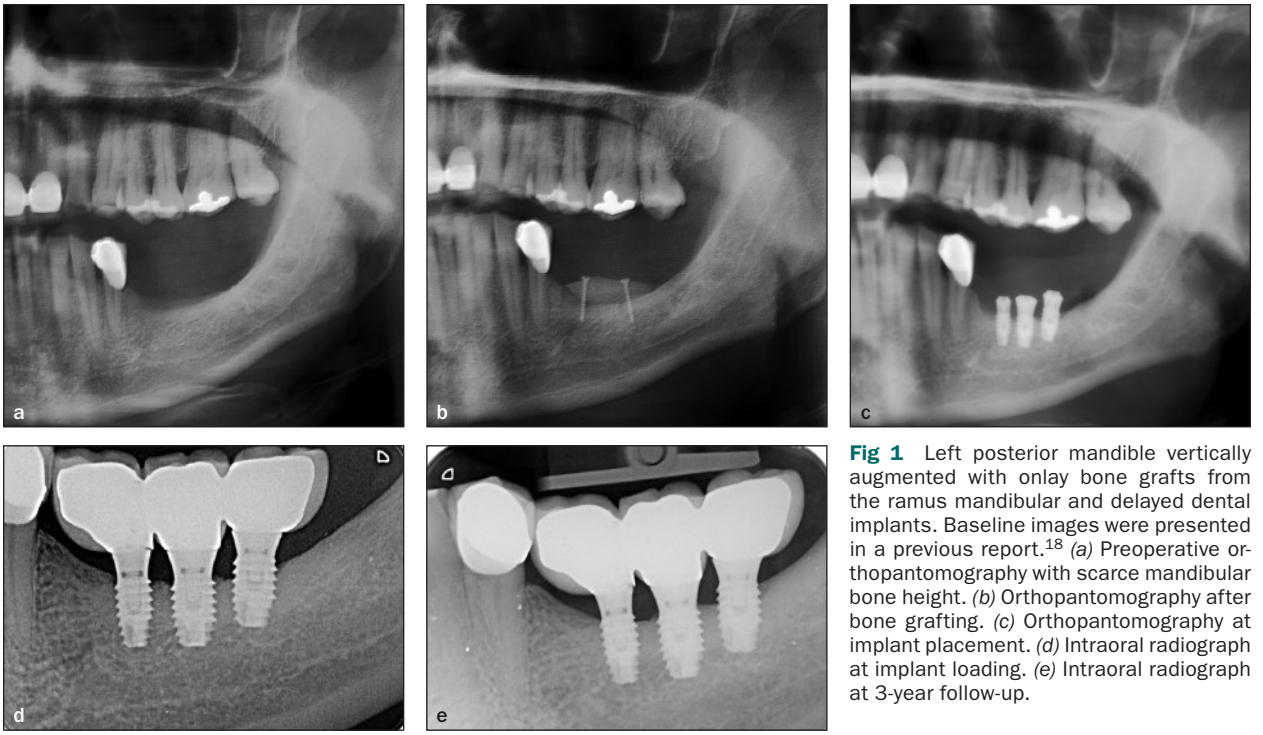

Fig 1 Left posterior mandible vertically augmented with onlay bone grafts from the ramus mandibular and delayed dental implants. Baseline images were presented in a previous report.[18] *(a)* Preoperative orthopantomography with scarce mandibular bone height. *(b)* Orthopantomography after bone grafting. *(c)* Orthopantomography at implant placement. *(d)* Intraoral radiograph at implant loading. *(e)* Intraoral radiograph at 3-year follow-up.

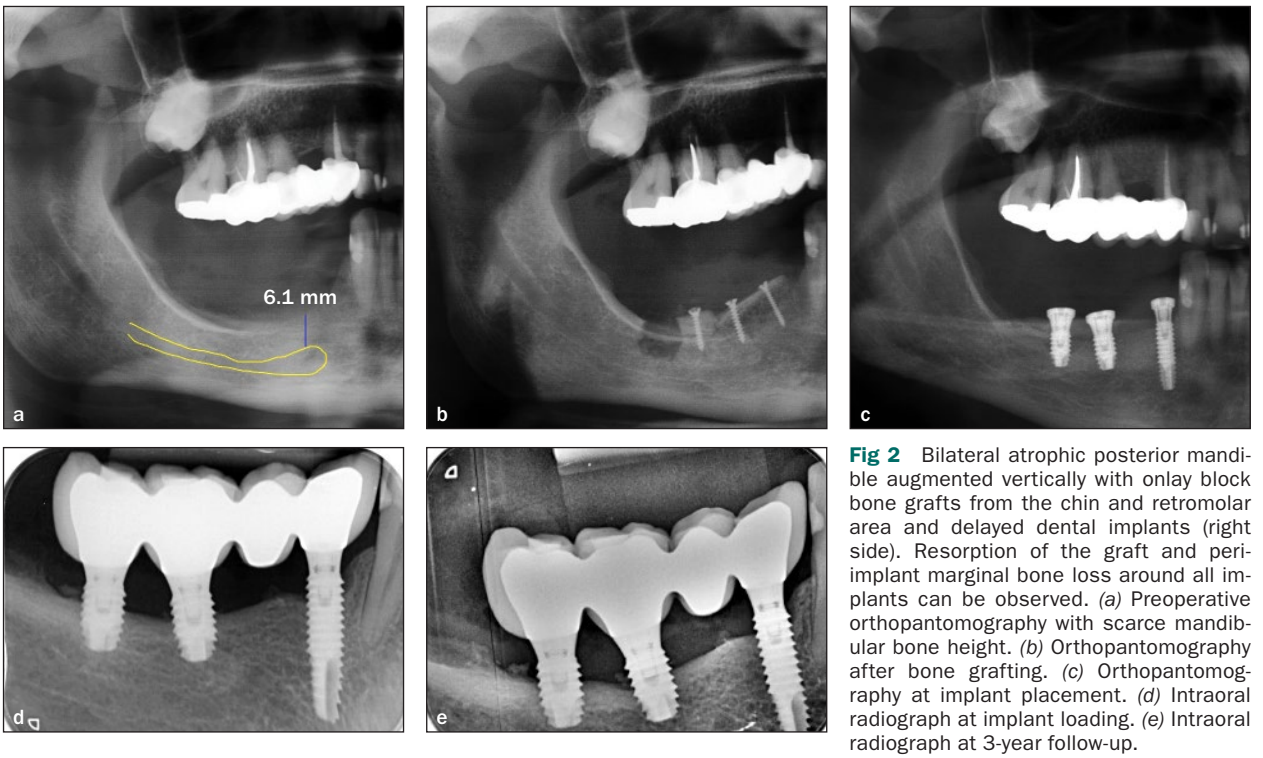

Fig 2 Bilateral atrophic posterior mandible augmented vertically with onlay block bone grafts from the chin and retromolar area and delayed dental implants (right side). Resorption of the graft and periimplant marginal bone loss around all implants can be observed. *(a)* Preoperative orthopantomography with scarce mandibular bone height. *(b)* Orthopantomography after bone grafting. *(c)* Orthopantomography at implant placement. *(d)* Intraoral radiograph at implant loading. *(e)* Intraoral radiograph at 3-year follow-up.

© 2018 BY QUINTESSENCE PUBLISHING CO, INC. PRINTING OF THIS DOCUMENT IS RESTRICTED TO PERSONAL USE ONLY.
NO PART MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM WITHOUT WRITTEN PERMISSION FROM THE PUBLISHER.

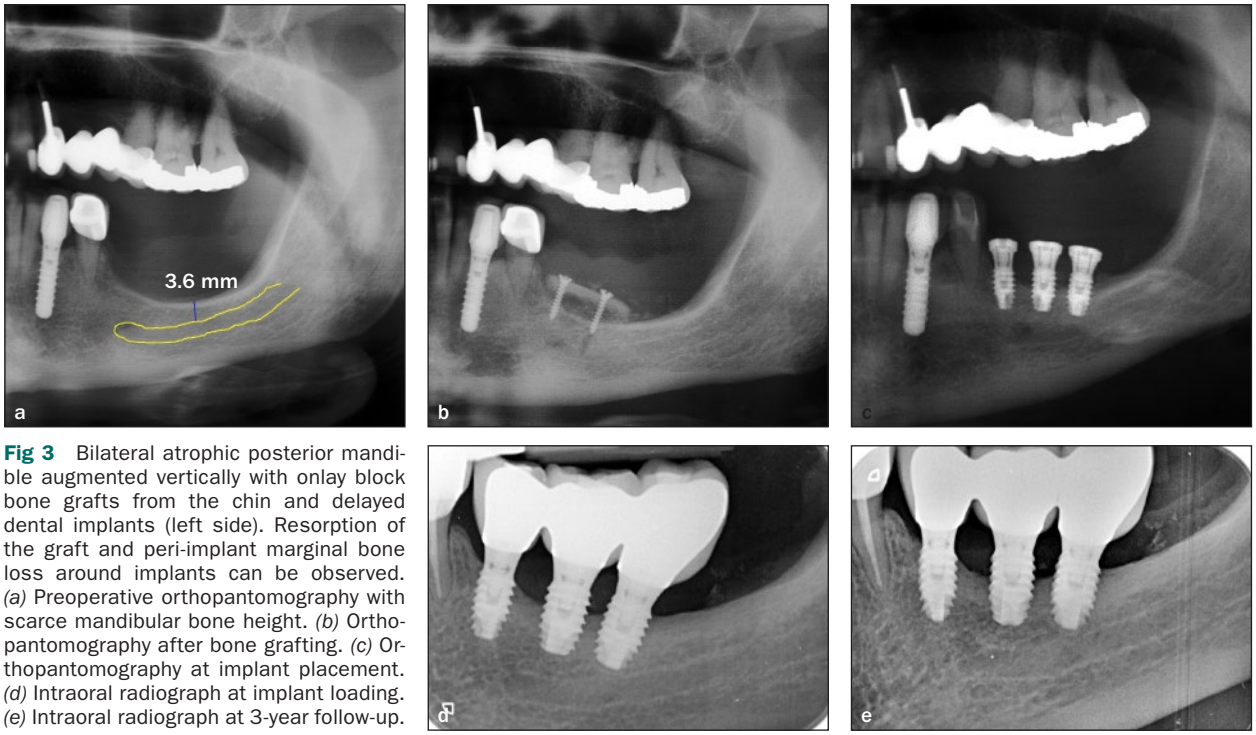

Fig 3 Bilateral atrophic posterior mandible augmented vertically with onlay block bone grafts from the chin and delayed dental implants (left side). Resorption of the graft and peri-implant marginal bone loss around implants can be observed. *(a)* Preoperative orthopantomography with scarce mandibular bone height. *(b)* Orthopantomography after bone grafting. *(c)* Orthopantomography at implant placement. *(d)* Intraoral radiograph at implant loading. *(e)* Intraoral radiograph at 3-year follow-up.

Table 2 Peri-implant Soft Tissue Data

Variable	Mean ± SD (range)
Plaque Index (mean)	0.19 ± 0.60 (0–2)
Bleeding Index (mean)	0.4 ± 1.02 (0–3)
Facial probing depth (mean)	3.22 ± 1.42 (1.3–6.3)
Lingual probing depth (mean)	2.90 ± 1.09 (1–5.6)
Facial recession (%)	38.8
Facial recession (mean)	–0.31 ± 0.75 (0–3)
Facial keratinized mucosa ≥ 3 mm (%)	52.7
Facial keratinized mucosa (mean)	2.71 ± 1.68 (1–5)
Peri-implant health status	
Healthy (%)	55.5
Mucositis (%)	19.5
Peri-implantitis (%)	25

Table 3 Five Questions Evaluating Patient Quality of Life and Satisfaction

Items	Mean	SD	Range
Did the implant therapy improve your quality of life?	9.19	0.40	9–10
Did the esthetic outcome of the implant crown meet your expectations?	8.42	0.67	7–9
Did the esthetic result of the mucosa surrounding the crown of the implant satisfy you?	7.71	1.45	6–9
Has the mucosa around the implant crown been stable over time? (the level of the marginal mucosa around the crown)	7.85	1.27	6–10
Would you undergo the same therapy again?	9.71	0.46	9–10
Chewing	8.68	0.94	6–10
Ease of cleaning	8.01	1.03	7–10

of failed implants. The mean facial mucosa recession was –0.4 ± 0.46 mm (range: 0 to 1). The mean facial keratinized mucosa band width was 2 ± 0.81 mm, versus 3.3 ± 1.2 mm (range: 1 to 8) for implants with healthy hard tissues ($P = .055$).

Patient Satisfaction and Quality of Life

The mean quality of life score was high (9.19 ± 0.40). The mean overall general satisfaction score was 8.07 ± 1.04 (mucosa esthetics: 7.71 ± 1.45; prosthesis esthetics: 8.42 ± 0.6) (Table 3). Statistically significant differences were found between the presence of recession and mucosal and prosthesis esthetics ($P = .034$ and $P = .023$, respectively). Patient age was correlated with mucosal esthetics ($P < .01$) but not with prosthesis esthetics ($P = .072$). The relationship between esthetics and sex was statistically significant (mucosal: $P = .04$; prosthesis: $P = .04$).

© 2018 BY QUINTESSENCE PUBLISHING CO, INC. PRINTING OF THIS DOCUMENT IS RESTRICTED TO PERSONAL USE ONLY.
NO PART MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM WITHOUT WRITTEN PERMISSION FROM THE PUBLISHER.

Patient satisfaction in terms of chewing and ease of cleaning was high, 8.68 ± 0.94 and 8.01 ± 1.03, respectively, and not correlated with age or sex ($P > .05$).

DISCUSSION

This study was designed to evaluate the peri-implant tissues in the edentulous posterior atrophic mandible vertically reconstructed with intraoral onlay bone grafts after 3 years of prosthetic loading. The study analyzed peri-implant health status, soft tissue parameters, implant success rate, radiographic marginal bone loss, quality of life, and patient satisfaction.

To the authors' knowledge, no article in the literature has considered the soft tissue contour changes or esthetic issues of implants placed in vertical defects previously augmented with onlay bone grafts. Chiapasco et al[13] assessed PI and BI, and probing depth, but not the marginal mucosal level or the WKM. Soft tissue appearance around implant restorations is of paramount importance for the success of implant therapy.[17] Two prerequisites have been highlighted to achieve a proper mucosal profile on the facial aspect: first, correct implant positioning in the orofacial and coronal-apical directions is required; and second, a facial bone wall of sufficient height and thickness is needed to support the mucosa.[26,30] Several studies have demonstrated that thick gingivae have a lower risk of midfacial margin recession.[31,32] In contrast, other authors have not found correlations between these variables.[33] In the present study, facial recession was observed in 38.8% of the implants; no significant correlations were found with the biotype, donor site location, or sex.

Despite the fact that intramembranous mandibular bone grafts have been related to a decreased resorption rate when compared with bone grafts harvested from extraoral sites,[34] it is unknown whether the resorption is an ongoing process.[35] In several studies, mean bone graft resorption before implant placement in defects vertically augmented with autogenous onlay bone grafts varied from 0.6 ± 0.7 mm[33] to 1 ± 1.46 mm.[35] For some clinicians, the remodeling of bone grafts consolidates after implant placement,[9] due to implants transmitting occlusal or transmucosal stimuli to peri-implant bone, which may maintain bone volume.[10] However, an uncertain amount of vertical resorption around the peri-implant bone has been reported over time.[8] Chiapasco et al[8] found a mean peri-implant bone resorption of 0.52 ± 0.45 mm at 2 to 3 years after vertical bone grafting by using autogenous onlay bone grafts, and the success rate was 93.1%. Similarly, Chiapasco et al[13] reported a mean bone loss of 0.3 ± 0.3 mm at loading time for implants placed in areas vertically augmented with onlay ramus mandibular grafts versus 0.9 ± 0.4 mm at 1 year (ie, a bone loss of 0.6 mm after loading), and 1.3 ± 0.4 mm at 3 years postloading (ie, a bone loss of 1 mm after loading). The cumulative success rate was 89.5% 4 years after loading. The greatest changes in bone levels during the early phases of loading may occur due to the immature bone quality in the most coronal part of the reconstructed ridges.[36] It has been reported that bone resorption is greater in the first year after bone grafting and in the first year after implant loading, whereas this resorption is significantly reduced in the subsequent years.[37] In the present study, at 3 years postloading, 25% of the implants showed a statistically significant marginal bone loss. These data may indicate that block bone grafts suffer some degree of bone resorption after prosthetic loading. Resorption of the block bone graft may leave the implant surface exposed to the environment, which can contribute to plaque retention, acting as a triggering factor for peri-implantitis. The type of bone, the extent of the area augmented, the presence or absence of peri-implant infection, the implant design, the apicocoronal implant position, the patient biotype, and the effect of functional loading on facial tissue remodeling over time may affect the pattern of bone resorption.[7,8] Furthermore, this accentuated bone loss may be due to confluence of the establishment of the biologic width and the biologic resorption process of the block bone grafts. In any case, it might be risky to assign a diagnosis of peri-implantitis to these implants, since not all implants met the criteria of the Consensus Report of the VI European Workshop on Periodontology.[29]

A probing depth > 4 mm and a marginal bone loss around implants in radiography are the most valid parameters confirming peri-implantitis.[25,38] In this study, the implants with a statistically significantly higher bone loss also were related to a statistically significantly higher probing depth. A relevant factor of periodontal stability is the absence of bleeding after probing; consequently, it is a reliable parameter for peri-implantitis risk assessment.[39] In the present study, out of nine implants with marked marginal bone loss, only five showed positive bleeding. Biologic resorption of the grafted bone may have exposed these implants to an increased risk of peri-implantitis. Hence, it is difficult to differentiate between bone resorption secondary to the biologic process and that attributable to peri-implantitis.

Studies assessing patients' level of satisfaction on esthetics, oral function, and quality of life are scarce.[40–42] Up to now, clinical research on patient-based outcomes has mainly been focused on implant-supported denture treatment for edentulous patients, but consideration of single crowns and partial dentures in posterior mandibular sites is not accurately described in the literature.[19] To the authors' knowledge, this is the first work analyzing these criteria on implants placed in vertically augmented posterior mandibles with block

© 2018 BY QUINTESSENCE PUBLISHING CO, INC. PRINTING OF THIS DOCUMENT IS RESTRICTED TO PERSONAL USE ONLY.
NO PART MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM WITHOUT WRITTEN PERMISSION FROM THE PUBLISHER.

bone grafts. In the present study, all patients reported good quality of life and would undergo the same procedure again. Esthetic outcomes were high (8.4, prostheses; 7.7, peri-implant mucosa); older patients scored higher on the VAS, which has been found by other authors.[18] Patient satisfaction in terms of chewing and ease of cleaning was high. Pjetursson et al[20] reported that 97% of patients following single crowns or fixed partial prostheses were highly satisfied or satisfied in terms of chewing comfort (mean VAS: 94 ± 13), and most of the patients (93%, mean VAS: 89 ± 19) reported no difficulties with cleaning the prostheses. Similarly, other authors found high chewing scores and lower but still high cleaning scores following fixed partial implant-supported rehabilitations.[21,22] Tan et al[21] found that 95% of patients were definitely or somewhat satisfied with the esthetic appearance, 96% with chewing comfort, 86% with cleaning, and 100% with the ability to speak normally at 5 years of follow-up. Yi et al[22] reported that a greater number of the patients were highly satisfied with the oral function in terms of phonetics, oral hygiene, chewing comfort, and esthetics after a mean of 1.8 years after prosthetic loading.

This is a small sample study with a 17% patient and 20.1% implant dropout rate. In this regard, assessing original bone graft size and having an extra recording at implant placement to calculate early bone loss associated with bone grafting would have strengthened the scientific value of the study. Efforts should be directed toward trials with larger samples, comparative randomized designs, and long-term follow-up periods to support these findings.

CONCLUSIONS

Considering the limitations of the study, implants in vertically augmented posterior mandibular areas with intraoral onlay block bone grafts showed good soft tissue levels and high patient satisfaction. No implants were lost at 3 years postloading, but one-fifth of the patients showed a statistically significant marginal bone loss.

ACKNOWLEDGMENTS

The authors reported no conflicts of interest related to this study.

REFERENCES

1. Laino L, Iezzi G, Piattelli A, Lo Muzio L, Cicciù M. Vertical ridge augmentation of the atrophic posterior mandible with sandwich technique: Bone block from the chin area versus corticocancellous bone block allograft—Clinical and histological prospective randomized controlled study. Biomed Res Int 2014;2014:982104.
2. Felice P, Iezzi G, Lizio G, Piattelli A, Marchetti C. Reconstruction of atrophied posterior mandible with inlay technique and mandibular ramus block graft for implant prosthetic rehabilitation. J Oral Maxillofac Surg 2009;67:372–380.
3. Esposito M, Grusovin MG, Felice P, Karatzopoulos G, Worthington HV, Coulthard P. The efficacy of horizontal and vertical bone augmentation procedures for dental implants—A Cochrane systematic review. Eur J Oral Implantol 2009;2:167–184.
4. Chiapasco M, Zaniboni M, Boisco M. Augmentation procedures for the rehabilitation of deficient edentulous ridges with oral implants. Clin Oral Implants Res 2006;17(suppl):s136–s159.
5. Roccuzzo M, Ramieri G, Spada MC, Bianchi SD, Berrone S. Vertical alveolar ridge augmentation by means of a titanium mesh and autogenous bone grafts. Clin Oral Implants Res 2004;15:73–81.
6. Jemt T, Lekholm U. Single implants and buccal bone grafts in the anterior maxilla: Measurements of buccal crestal contours in a 6-year prospective clinical study. Clin Implant Dent Relat Res 2005;7:127–135.
7. Pieri F, Aldini NN, Marchetti C, Corinaldesi G. Esthetic outcome and tissue stability of maxillary anterior single-tooth implants following reconstruction with mandibular block grafts: A 5-year prospective study. Int J Oral Maxillofac Implants 2013;28:270–280.
8. Chiapasco M, Casentini P, Zaniboni M. Implants in reconstructed bone: A comparative study on the outcome of Straumann tissue level and bone level implants placed in vertically deficient alveolar ridges treated by means of autogenous onlay bone grafts. Clin Implant Dent Relat Res 2014;16:32–50.
9. Rubin CT, Lanyon LE. Regulation of bone formation by applied dynamic loads. J Bone Joint Surg Am 1984;66:397–402.
10. Cordioli G, Majzoub Z, Riachi F. Postloading behavior of regenerated tissues in GBR-treated implant sites. Int J Periodontics Restorative Dent 1999;19:44–55.
11. Schneider D, Grunder U, Ender A, Hämmerle CH, Jung RE. Volume gain and stability of peri-implant tissue following bone and soft tissue augmentation: 1-year results from a prospective cohort study. Clin Oral Implants Res 2011;22:28–37.
12. 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(suppl):s203–s215.
13. Chiapasco M, Zaniboni M, Rimondini L. Autogenous onlay bone grafts vs. alveolar distraction osteogenesis for the correction of vertically deficient edentulous ridges: A 2-4-year prospective study on humans. Clin Oral Implants Res 2007;18:432–440.
14. Levin L, Nitzan D, Schwartz-Arad D. Success of dental implants placed in intraoral block bone grafts. J Periodontol 2007;78:18–21.
15. Aloy-Prósper A, Peñarrocha-Oltra D, Peñarrocha-Diago M, Peñarrocha-Diago M. The outcome of intraoral onlay block bone grafts on alveolar ridge augmentations: A systematic review. Med Oral Patol Oral Cir Bucal 2015;20:e251–e258.
16. Gu YX, Shi JY, Zhuang LF, Qiao SC, Xu YY, Lai HC. Esthetic outcome and alterations of soft tissue around single implant crowns: A 2-year prospective study. Clin Oral Implants Res 2015;26:909–914.
17. Luo Z, Zeng R, Luo Z, Chen Z. Single implants in the esthetic zone: Analysis of recent peri-implant soft tissue alterations and patient satisfaction. A photographic study. Int J Oral Maxillofac Implants 2011;26:578–586.
18. de Lima EA, dos Santos MB, Marchini L. Patients' expectations of and satisfaction with implant-supported fixed partial dentures and single crowns. Int J Prosthodont 2012;25:484–490.
19. Petricevic N, Celebic A, Rener-Sitar K. A 3-year longitudinal study of quality-of-life outcomes of elderly patients with implant- and tooth-supported fixed partial dentures in posterior dental regions. Gerodontology 2012;29:e956–e963.
20. Pjetursson BE, Karoussis I, Bürgin W, Brägger U, Lang NP. Patients' satisfaction following implant therapy. A 10-year prospective cohort study. Clin Oral Implants Res 2005;16:185–193.
21. Tan K, Li AZ, Chan ES. Patient satisfaction with fixed partial dentures: A 5-year retrospective study. Singapore Dent J 2005;27:23–29.
22. Yi SW, Carlsson GE, Ericsson I, Kim CK. Patient evaluation of treatment with fixed implant-supported partial dentures. J Oral Rehabil 2001;28:998–1002.

© 2018 BY QUINTESSENCE PUBLISHING CO, INC. PRINTING OF THIS DOCUMENT IS RESTRICTED TO PERSONAL USE ONLY.
NO PART MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM WITHOUT WRITTEN PERMISSION FROM THE PUBLISHER.

23. Vandenbroucke JP, von Elm E, Altman DG, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): Explanation and elaboration. Epidemiology 2007;18:805–835.
24. Peñarrocha-Oltra D, Aloy-Prósper A, Cervera-Ballester J, Peñarrocha-Diago M, Canullo L, Peñarrocha-Diago M. Implant treatment in atrophic posterior mandibles: Vertical regeneration with block bone grafts versus implants with 5.5-mm intrabony length. Int J Oral Maxillofac Implants 2014;29:659–666.
25. Mombelli A, van Oosten MA, Schurch E Jr, Land NP. The microbiota associated with successful or failing osseointegrated titanium implants. Oral Microbiol Immunol 1987;2:145–151.
26. Buser D, Wittneben J, Bornstein MM, Grütter L, Chappuis V, Belser UC. Stability of contour augmentation and esthetic outcomes of implant-supported single crowns in the esthetic zone: 3-year results of a prospective study with early implant placement postextraction. J Periodontol 2011;82:342–349.
27. Lang NP, Berglundh T, Working Group 4 of Seventh European Workshop on Periodontology. Periimplant diseases: Where are we now?—Consensus of the Seventh European Workshop on Periodontology. J Clin Periodontol 2011;38(suppl):s178–s181.
28. Buser D, Mericske-Stern R, Dula K, Lang NP. Clinical experience with one-stage, non-submerged dental implants. Adv Dent Res 1999;13:153–161.
29. Harris EF, Smith RN. Accounting for measurement error: A critical but often overlooked process. Arch Oral Biol 2009;54(suppl):s107–s117.
30. Kan JY, Rungcharassaeng K, Umezu K, Kois JC. Dimensions of peri-implant mucosa: An evaluation of maxillary anterior single implants in humans. J Periodontol 2003;74:557–562.
31. Lee A, Fu JH, Wang HL. Soft tissue biotype affects implant success. Implant Dent 2011;20:e38–e47.
32. Cabello G, Rioboo M, Fabrega JG. Immediate placement and restoration of implants in the aesthetic zone with a trimodal approach: Soft tissue alterations and its relation to gingival biotype. Clin Oral Implants Res 2013;24:1094–1100.
33. Verdugo F, Simonian K, Frydman A, D'Addona A, Pontón J. Long-term block graft stability in thin periodontal biotype patients: A clinical and tomographic study. Int J Oral Maxillofac Implants 2011;26:325–332.
34. Zins JE, Whitaker LA. Membranous vs endochondral bone: Implications for craniofacial reconstruction. Plast Reconstr Surg 1983;72:778–785.
35. Proussaefs P, Lozada J. The use of intraorally harvested autogenous block grafts for vertical alveolar ridge augmentation: A human study. Int J Periodontics Restorative Dent 2005;25:351–363.
36. Schenk RK. Bone regeneration: Biologic basis. In: Buser D, Dahlin C, Schenk RK (eds). Guided Bone Regeneration in Implant Dentistry. Chicago: Quintessence, 1994:49–100.
37. Verhoeven JW, Ruijter J, Cune MS, Terlou M, Zoon M. Onlay grafts in combination with endosseous implants in severe mandibular atrophy: One year results of a prospective, quantitative radiological study. Clin Oral Implants Res 2000;11:583–594.
38. Mishler OP, Shiau HJ. Management of peri-implant disease: A current appraisal. J Evid Based Dent Pract 2014;14(suppl):s53–s59.
39. Sahrmann P, Attin T, Schmidlin PR. Regenerative treatment of peri-implantitis using bone substitutes and membrane: A systematic review. Clin Implant Dent Relat Res 2011;13:46–57.
40. Schlee M, Dehner JF, Baukloh K, Happe A, Seitz O, Sader R. Esthetic outcome of implant-based reconstructions in augmented bone: Comparison of autologous and allogeneic bone block grafting with the pink esthetic score (PES). Head Face Med 2014;10:21.
41. Soehardi A, Meijer GJ, Strooband VF, de Koning M, Stoelinga PJ. The potential of the horizontal ramus of the mandible as a donor site for block and particular grafts in pre-implant surgery. Int J Oral Maxillofac Surg 2009;38:1173–1178.
42. Hof M, Pommer B, Strbac GD, Sütö D, Watzek G, Zechner W. Esthetic evaluation of single-tooth implants in the anterior maxilla following autologous bone augmentation. Clin Oral Implants Res 2013;24(suppl):s88–s93.

© 2018 BY QUINTESSENCE PUBLISHING CO, INC. PRINTING OF THIS DOCUMENT IS RESTRICTED TO PERSONAL USE ONLY.
NO PART MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM WITHOUT WRITTEN PERMISSION FROM THE PUBLISHER.