Evaluation of survival of 8 mm-length implants in posterior resorbed ridges: A pilot study

Bangalore Sridhar Shilpa, Seegavadi Dwarkanathan Vasudevan,¹ Manohar Laxman Bhongade, Vidya Baliga, Vikas Vilas Pakhare, Prasad Vijayrao Dhadse

Abstract:
Context: Rehabilitation of jaws with reduced bone height is technically demanding and expensive. Short implants are emerging as an alternate in such cases. Aim: This study aimed to evaluate the survival of implants of 8 mm in length (short implants), clinically and radiographically, in posterior resorbed ridges. Materials and Methods: A total of 11 patients with single missing posterior tooth, having 9–10 mm of residual bone height determined using radiographs, were selected for the study. Twelve implants of 8 mm length were inserted in the resorbed alveolar ridges following standard operating procedure. A second-stage surgery was performed 4–6 months after implant placement for placement of gingival former. This was followed by placement of prosthesis. Twelve months after prosthesis placement, all the patients were examined clinically and radiographically. Results: According to Albrektsson et al.’s criteria, all implants were successful with mean bone loss of 1.1 ± 0.32 mm mesially and 0.83 ± 0.35 mm distally with healthy gingival condition at 12-month follow-up. Conclusion: Short implants (8 mm in length) can be a viable alternative in cases of atrophic alveolar ridges.

Key words: 8-mm implants, atrophic ridges, short implants, survival

INTRODUCTION
In the last few decades, implants have become a highly predictable surgical procedure for replacing single or multiple missing teeth. However, in cases of decreased residual bone height, placement of dental implants is an arduous task as insufficient residual bone height increases the probability of injury to vital structures such as maxillary sinus and the inferior alveolar nerve.¹ In such clinical scenarios, various ridge augmentation procedures such as guided bone regeneration, onlay bone grafting,² lateralization or transposition of the inferior alveolar nerve in atrophic mandible,³ and sinus augmentation procedures in posterior atrophic maxilla have been suggested. These procedures are expensive, technically demanding, associated with significant postoperative morbidity, and may require longer rehabilitation periods.

Implants of lesser length have been advocated as a substitute in resorbed ridges to prevent such invasive surgical procedures and reduce postoperative complications and morbidity.⁴ das Neves et al.¹ considered short implants to have an intrabony length of 7–10 mm. However, Renouard and Nisand⁵ have redefined short implants as those that have intrabony length of 8 mm or less. In the present study, implants with 8 mm of intrabony length were considered as short implants. Short implants appear to be a lucrative alternate in cases where adjunctive implant surgeries are needed to place conventional implants. In the past, short implants were associated with lower survival rates.⁵⁶ In contrast, studies by Nedir et al.,⁷ Telleman et al.,⁸ and Annibali et al.⁹ have found that success rate of short implants is comparable with implants that are of 10 mm in length or longer. Therefore, the present study was undertaken to evaluate the survival of 8-mm implants, clinically and radiographically, in posterior resorbed ridges.
MATERIALS AND METHODS

The present study was conducted after getting approval from the Institutional Ethics Committee. A written informed consent was obtained from each patient after explaining the study protocol. A total of 11 patients were selected from the department of periodontics using the following criteria.

Inclusion criteria
1. Patients who were 18 years of age or older
2. Single missing tooth in posterior regions of either maxillary and/or mandibular arch
3. Residual bone height ranging from 9 to 10 mm between alveolar crest and the floor of the sinus or inferior dental canal
4. At least 3 months of healing after extraction
5. Natural tooth adjacent to edentulous space needs to have an intact occlusal surface and free from any pathology
6. Presence of natural opposing teeth or prosthesis.

Exclusion criteria
1. Presence of untreated periodontal diseases and caries
2. Patients with a history of systemic disorders such as uncontrolled diabetes mellitus and pregnancy that could affect the outcome of implant therapy
3. Patients with narrow alveolar ridges requiring bone augmentation in planned implant area.

Clinical examination
Patients’ oral hygiene status was evaluated using Full Mouth Plaque Index (FMPI)[10] and gingival bleeding was evaluated using Full Mouth Papillary Bleeding Index (FMBI).[11] These scores were recorded at baseline and 12 months after the final prostheses were fitted. This was carried out to assess oral hygiene status of patients as poor oral hygiene could affect the outcome of implant therapy. Clinically, mesiodistal and buccolingual widths of the alveolar ridge at the edentulous site were measured with the University of North Carolina probe (UNC 15, Hu-Friedy, Chicago, IL, USA).

Radiographic examination
Preoperative orthopantomogram [Figure 1] was taken to assess residual bone height. Digital volumetric tomography (DVT) scan [Figure 2a and b] was performed at baseline to measure the following:
1. In maxillary arch, distance from floor of sinus to crest of the alveolar ridge
2. In mandibular arch, from crest of alveolar ridge to inferior dental canal
3. Mesiodistal length of the alveolar ridge
4. Buccopalatal/buccolingual width of the ridge
5. Thickness of buccal and palatal/lingual cortical plates
6. Presence of any septa or sinus pathology/variations in inferior alveolar nerve.

Surgical protocol
All the dental implants (Equinox, Myriad Plus™ implant system, Equinox Medical Technologies B.V. de Stuwdam, Netherlands) were placed using a two-stage protocol. After flap reflection, osteotomy at implant site was carried out using standard sequential drills depending on the diameter of the implant, under copious irrigation, taking care of the anatomical boundaries.

Once the osteotomy site was prepared, the largest and widest possible implant [Figure 3] was placed in the recipient site based on preoperative measurements [Figure 4]. The flap was positioned over the implant after placement of healing screw. The flap margins were approximated by simple interrupted sutures (silk 3-0, Ethicon, Johnson and Johnson Ltd, Ethicon US LLC). Soft-tissue closure without tension was achieved and the implant remained submerged and was not exposed to oral environment until the second-stage surgery. Immediate postoperative intraoral periapical (IOPA) radiographs were taken to confirm complete seating of the implants [Figure 5]. All the patients received antibiotics (capsule amoxicillin, 500 mg 8 hourly) and analgesics (tablet diclofenac 50 mg) twice daily for 5 days after surgery. Chlorhexidine digluconate rinse (Rexidine®, Indoco Remedies Ltd, Mumbai, India) was advocated twice a day. Seven to ten days after the surgery, the sutures were removed. Four to six months after implant placement, the second-stage surgery was performed to expose the submerged implant and a gingival former was connected [Figure 6] to allow guided soft-tissue healing for 3–4 weeks. Abutment connection was carried out after removal of the gingival former. Single porcelain fused to metal crown was fabricated and all the crowns were cemented [Figure 7]. Twelve months following crown placement, the patients were recalled for clinical and radiographic examinations [Figures 8 and 9].

The following clinical measurements were recorded around each implant: width of keratinized gingiva (WKG), gingival recession (GR), probing pocket depth (PPD), Modified Plaque Index (MPI),[12] and Modified Bleeding Index (MBI).[12] Clinical Implant Mobility Scale (CIMS)[13] was also measured. A periodontal probe (UNC 15, Hu-Friedy, Chicago, IL, USA) was used at four sites (i.e., mesial, buccal, distal, and lingual) around each implant to record PPD and clinical attachment level (CAL). For the probing measurements, the reference line taken into consideration was implant shoulder. All the measurements recorded immediately after placement of crowns were considered as baseline values (T0). The measurements recorded 12 months after crown placement were considered as (T1).

IOPAs were taken at each implant site by paralleling technique with a long cone (XCP Rinn, Dentsply Ltd, Surrey, UK) at baseline (T0) and at 12 months after loading (T1). Following the processing of the IOPAs, a film mounted with a millimeter grid scale (Nix Company Ltd., Tokyo, Japan) was used for radiographic measurements. To measure the changes in the interproximal alveolar crestal bone height, IOPA with printed scale lines was used. From the mesial and distal aspects of each implant, distance from implant shoulder to the most coronal crestal bone in contact with implant (DIB) was measured. The values were expressed in millimeter. For each implant, mean bone loss at mesial and distal sites was calculated at baseline (T0) and at 12 months after loading (T1).

Clinical and radiographic evaluation was performed at 12 months after placement of metal-ceramic restoration. Evaluation for any biological complications such as peri-implant mucositis and peri-implantitis was carried out. Complications such as loosening of abutment screw, chipping of ceramic crown, and fracture of implant were also examined. Albrektsson et al’s,[14] success criteria were
Shilpa, et al.: Survival and success rates of short implants: A pilot study

**Figure 1:** Preoperative orthopantomogram

**Figure 2:** (a and b) Preoperative digital volumetric tomography

**Figure 3:** Short implant (8 mm in length)

**Figure 4:** After placement of implant

**Figure 5:** Immediate postoperative intraoral periapical radiograph

**Figure 6:** Connection of gingival former after second-stage surgery

**Figure 7:** After placement of final prosthesis

**Figure 8:** Probing measurements around implants
applied to determine the success or failure of an implant. The criteria included immobile implants, no persistent pain or paresthesia, adequate function, no damage to anatomic structures such as maxillary sinus or inferior alveolar nerve, healthy peri-implant tissue, bone loss at the 1st year should be <1.5 mm, and absence of peri-implant radiolucency. The mean for all clinical and radiographic values was calculated for each implant.

RESULTS

The present study was performed over a 2-year period. All the selected patients were treated by placement of 8-mm implants (short implants) in residual bone height of 9–10 mm. A second-stage surgery was carried out after 4–6 months to expose the implants for placement of gingival formers followed by placement of abutment and metal-ceramic restorations. A total of 11 systemically healthy patients were recruited. Twelve short implants of length 8 mm were placed using delayed loading protocol [Table 1]. All the patients reported for follow-up throughout the study. Preoperative measurements at each implant site using DVT scan along with distribution and sizes of implants are mentioned in Table 2. All the surgical sites healed uneventfully. The prosthetic rehabilitation was functional and in good condition throughout the study period.

The FMPI[10] and FMBI[11] scores at baseline (T0) and at 12 months (T1) after loading are shown in [Table 3]. Radiographic bone level at implant site on mesial and distal surfaces at baseline (T0) and 12 months (T1) after final prosthetic rehabilitation is presented in [Table 4]. All implants showed CIMS of 0 at 12 months after fixed restoration. Measurements of clinical parameters around implants at 12 months after final restoration including mean MPI,[12] MBI,[12] PPD, GR, and WKG are shown in [Table 5].

DISCUSSION

The purpose of the present study was to evaluate the survival of short implants of 8 mm in length (short implants) in posterior atrophic regions with single-unit crowns. The study emphasizes the survival of implants of 8 mm in length (short implants) in terms of crestal bone changes around implant and by assessing peri-implant changes using radiographic and clinical parameters, respectively. Plaque accumulation around implants has been shown to induce inflammation and loss of marginal bone.[15] Good plaque control has been shown to prevent plaque-induced marginal bone loss around implants.[16] Each patient participating in the study maintained a good oral hygiene level and a healthy clinical gingival condition throughout the study period which was evident by low FMPI, FMPBI, MPI, MBI, and PPD scores. This was the result of the repeated oral hygiene instructions given to the patient. Minimal gingival recession was observed in some cases due to thin gingival biotype. However, recession did not progress in subsequent follow-ups. Prosthetic rehabilitation was functional and in good condition throughout the study period. In the present study, all the implants were well embedded in the bone as revealed by the radiographic analysis. Mean vertical bone loss (DIB) on mesial surface was 1.05 mm, while on distal surface, it was 0.64 mm at 12 months after fixed prosthesis. The greater marginal bone loss during the 1st year could be due to trauma and inflammation to the tissue during surgery. Experiments have shown that

![Figure 9: Introral periapical radiograph 12 months after final prosthesis](image)

| Table 1: Patient characteristics |
|---------------------------------|
| Number of patients             | 11 |
| Number of implant sites         | 12 |
| Mean age (years)               | 35.58±9.17 |
| Female:male ratio              | 6:5 |
| Number of sites in mandible    | 4  |
| Number of sites in maxilla     | 8  |
| Residual bone height (range)   | 9-11 mm |

| Table 2: Dimensions of implants and site of implants |
|------------------------------------------------------|
| Patient number | Site of implant placement | Mesiodistal width (mm) on DVT | Buccolingual width (mm) on DVT | Residual bone height (mm) on DVT | Dimensions of implants (diameter and length) in mm |
|----------------|---------------------------|--------------------------------|---------------------------------|---------------------------------|---------------------------------|
| 1              | 47                        | 13.50                          | 7.40                            | 10.14                           | 4.5×8                           |
| 2              | 26                        | 10.70                          | 9.73                            | 10.01                           | 4.5×8                           |
| 3              | 15                        | 5.62                           | 5.71                            | 10.19                           | 3.8×8                           |
| 4              | 26                        | 8.80                           | 9.80                            | 9.80                            | 4.5×8                           |
| 5              | 16                        | 9.5                            | 6.33                            | 10.01                           | 4.5×8                           |
| 6              | 36                        | 9.6                            | 5.13                            | 9.51                            | 3.8×8                           |
| 7              | 15                        | 8.41                           | 6.92                            | 10.14                           | 3.8×8                           |
| 8              | 47                        | 13.06                          | 7.40                            | 9.24                            | 4.5×8                           |
| 9              | 16                        | 10.36                          | 4.53                            | 10.04                           | 3.8×8                           |
| 10             | 16                        | 9.19                           | 6.02                            | 9.94                            | 4.5×8                           |
| 11             | 25                        | 8.16                           | 6.08                            | 9.51                            | 3.8×8                           |
| 12             | 25                        | 5.62                           | 5.80                            | 10.1                            | 3.8×8                           |

DVT – Digital volumetric tomography
the initial necrosis of bone occurs adjacent to the implant. Further bone loss has been observed after loading of implant due to adaptive remodeling to forces until a steady state is established.\[17\] Pieri\ et\ al\[18\] reported mean marginal bone level at the start of prosthetic loading 0.27 mm around short implant of length 6 mm which was decreased to 0.40 mm, 0.51 mm, and 0.60 mm after 6-month and 1- and 2-year follow-up, respectively. Mertens\ et\ al\[19\] observed bone resorption of 0.24 mm mesially and 0.36 mm distally around short implants of length 8 and 9 mm, respectively, after 10.1 years of implant placement. Anitua\ et\ al\[20\] reported mean mesial bone loss of 0.88 mm and mean distal bone loss of 0.52 mm around 26 short implants of length 5.5–6.5 mm with a loading period up to 6 months. The findings of our study are in concordance with these studies.

The implant survival rate in the present study using two-stage approach was found to be 100% after a follow-up period of 12 months. These results are comparable with the findings reported in previous studies on short implants. Mertens\ et\ al\[21\] evaluated the long-term survival of short implants (8 and 9 mm) in severely atrophic alveolar ridges retaining restorations and reported a survival rate of 100%. Grant\ et\ al\[22\] evaluated the success of short implants (8 mm in length) and reported an implant survival rate of 99% after a follow-up of 2 years. In a systematic review by Karthikeyan\ et\ al\[23\] on ≤7 mm (published between 1991 and 2011), the survival of short implants was found to increase from 80% to 90% gradually and recent articles show 100% survival. The finding in the present study suggests that the 8-mm short implants can be successfully placed in posterior regions of jaw with reduced bone height. In a meta-analysis of Fan\ et\ al\[24\] it was observed that there was no significant difference in the survival rate of short implants (5–8 mm) as compared with long implant group (>8 mm), with short implant group having lower complications than longer implants. A systematic review and meta-analysis by Lemos\ et\ al\[25\] comparing short dental implants (≤8 mm) with standard dental implants (>8 mm)

### Table 3: Comparison of Full Mouth Plaque Index and Full Mouth Papillary Bleeding Index scores between baseline and at 12 months after loading

| Parameters       | Mean value±SD | P       |
|------------------|---------------|---------|
| FMPPI            | 0.49±0.17     | 0.27 (NS) |
| FMBPI            | 0.50±0.17     | 0.70 (NS) |

P<0.05 - significant. SD – Standard deviation; FMPPI – Full Mouth Plaque Index; FMBPI – Full Mouth Papillary Bleeding Index; NS – Not significant; P – Probability value

### Table 4: Radiographic bone levels at implant sites on mesial and distal surfaces at baseline and at 12 months after final restoration

| Patient number | Vertical distance between shoulder of the implant and the most coronal bone to implant contact At baseline At 12 months Difference |
|----------------|-------------------------------------------------------------------------------------------------|
|                | Mesial | Distal | Mesial | Distal | Mesial | Distal |
| 1              | 0.5    | 0      | 1.0    | 0.5    | 0.5    | 0.5    |
| 2              | 0.5    | 0.5    | 1.5    | 1.0    | 1.0    | 0.5    |
| 3              | 0      | 0      | 0.5    | 0.5    | 0.5    | 0.5    |
| 4              | 0.5    | 0.5    | 1.5    | 1.0    | 1.0    | 0.5    |
| 5              | 0      | 0      | 1.0    | 0.5    | 1.0    | 0.5    |
| 6              | 0      | 0      | 1.0    | 0.5    | 1.0    | 0.5    |
| 7              | 0      | 0      | 1.5    | 1.0    | 1.5    | 1.0    |
| 8              | 0      | 0      | 1.5    | 1.0    | 1.5    | 1.0    |
| 9              | 0      | 0      | 1.0    | 1.0    | 1.0    | 1.0    |
| 10             | 0      | 0      | 0.5    | 0.5    | 0.5    | 0.5    |
| 11             | 0      | 0      | 1.0    | 0.5    | 1.0    | 0.5    |

Mean value±SD 0.13±0.23 0.08±0.19 1.1±0.32 0.89±0.35 1.05±0.28 0.64±0.24

P<0.001* <0.001*<0.05 ‑ significant. SD – Standard deviation; FMPPI – Full Mouth Plaque Index; FMBPI – Full Mouth Papillary Bleeding Index; NS – Not significant; P – Probability value

### Table 5: Measurement of clinical parameters around implants at 12 months after fixed restoration

| Patient number | Site of implant | MPI | MBI | PPD | GR | WKG |
|----------------|-----------------|-----|-----|-----|----|-----|
| 1              | 47              | 0.5 | 0.25| 2   | 0  | 3   |
| 2              | 26              | 0.5 | 0.5 | 2   | 0.25| 3   |
| 3              | 15              | 0.25| 0.25| 1.75| 0.25| 2   |
| 4              | 26              | 1   | 0.75| 2.25| 0.25| 2   |
| 5              | 16              | 0.5 | 0.5 | 2   | 0   | 2   |
| 6              | 36              | 0.5 | 0.5 | 2   | 0   | 2   |
| 7              | 15              | 0.25| 0.25| 1.25| 0   | 3   |
| 8              | 47              | 1   | 1   | 1.75| 0.5 | 2   |
| 9              | 46              | 0.5 | 0.25| 1.5 | 0   | 2   |
| 10             | 16              | 0.75| 0.5 | 1.5 | 0.25| 3   |
| 11             | 16              | 0.5 | 0.5 | 1.5 | 0   | 2   |

Mean value±SD 0.58±0.25 0.50±0.24 1.81±0.32 0.15±0.17 2.33±0.49

SD – Standard deviation; MPI – Modified Plaque Index; MBI – Modified Bleeding Index; PPD – Probing Pocket Depth; GR – Gingival Recession; WKG – Width of Keratinized Gingiva
placed in the posterior region of jaw showed that there was no significant difference of implant survival, marginal bone loss, complications, and prosthesis failure. From the above findings of the previous studies, the use of short implants has shown to be a predictable alternative in cases of moderately atrophic mandibles and/or pneumatization of the maxillary sinus.

CONCLUSION

The option considered in the present study required only minimally invasive surgery avoiding the need for extensive and traumatic surgical procedures, thus saving treatment costs and time. It can therefore be concluded that use of short implants under strict clinical protocol can be a safe technique with minimal bone resorption and 100% survival at 1-year follow-up. This study will be continued with larger sample size and longer follow-up.

Financial support and sponsorship Nil.

Conflicts of interest There are no conflicts of interest.

REFERENCES

1. das Neves FD, Fones D, Bernardes SR, do Prado CJ, Neto AJ. Short implants – An analysis of longitudinal studies. Int J Oral Maxillofac Implants 2006;21:86-93.
2. 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;18:432-40.
3. Rosenquist B. Implant placement in combination with nerve transpositioning: Experiences with the first 100 cases. Int J Oral Maxillofac Implants 1994;9:522-31.
4. Fortin T, Bosson JL, Isidori M, Blanchet E. Effect of flapless surgery on pain experienced in implant placement using an image-guided system. Int J Oral Maxillofac Implants 2006;21:298-304.
5. Renouard F, Nisand D. Impact of implant length and diameter on survival rates. Clin Oral Implants Res 2006;17 Suppl 2:35-51.
6. Moy PK, Bain CA. Relation between fixture length and implant failure. J Dent Res 1992;72:637-41.
7. Nedir R, Bischof M, Briaux JM, Beyer S, Szmukler-Moncler S, Bernard JP, et al. A 7-year life table analysis from a prospective study on ITI implants with special emphasis on the use of short implants. Results from a private practice. Clin Oral Implants Res 2004;15:150-7.
8. Telleman G, Raghoebhar GM, Vissink A, den Hartog L, Huddleston Slater JJ, Meijer HJ, et al. A systematic review of

the prognosis of short (<10 mm) dental implants placed in the partially edentulous patient. J Clin Periodontol 2011;38:667-76.
9. Annibali S, Cristalli MP, Dell’Aquila D, Bignozzi I, La Monaca G, Pilloni A, et al. Short dental implants: A systematic review. J Dent Res 2012;91:23-32.
10. Turesky S, Gilmore ND, Glickman I. Reduced plaque formation by the chloromethyl analogue of Victamine C. J Periodontol 1970;41:41-3.
11. Mühlemann HR. Psychological and chemical mediators of gingival health. J Prev Dent 1977;4:6-17.
12. Lang NP, Mombelli A, Brägger U, Hämmerle CH. Monitoring disease around dental implants during supportive periodontal treatment. Periodontol 2000 1996;12:60-8.
13. Misch CE. The implant quality scale: A clinical assessment of the health – Disease continuum. Oral Health 1998;88:15-20, 23-5.
14. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: A review and proposed criteria of success. Int J Oral Maxillofac Implants 1986;1:11-25.
15. Lindhe J, Berglundh T, Ericsson I, Liljenberg B, Marinello C. Experimental breakdown of peri-implant and periodontal tissues. A study in the beagle dog. Clin Oral Implants Res 1992;3:9-16.
16. Lindquist LW, Carlsson GE, Jemt T. A prospective 15-year follow-up study of mandibular fixed prostheses supported by osseointegrated implants. Clinical results and marginal bone loss. Clin Oral Implants Res 1996;7:329-36.
17. Sennerby L, Thomsen P, Ericson LE. Early tissue response to titanium implants inserted in rabbit cortical bone. Part I. light microscopic observations. J Mater Sci Mater Med 1993;4:240-50.
18. Pieri F, Aldini NN, Fini M, Marchetti C, Corinaldesi G. Preliminary 2-year report on treatment outcomes for 6-mm-long implants in posterior atrophic mandibles. Int J Prosthodont 2012;25:279-89.
19. Mertens C, Meyer-Bäumer A, Kappel H, Hoffmann J, Steveling HG. Use of 8-mm and 9-mm implants in atrophic alveolar ridges: 10-year results. Int J Oral Maxillofac Implants 2012;27:1501-8.
20. Anitua E, Alkhraisat MH, Orive G. Novel technique for the treatment of the severely atrophied posterior mandible. Int J Oral Maxillofac Implants 2013;28:1338-46.
21. Grant BT, Pancio FX, Kraut RA. Outcomes of placing short dental implants in the posterior mandible: A retrospective study of 124 cases. J Oral Maxillofac Surg 2009;67:713-7.
22. Karthikeyan I, Desai SR, Singh R. Short implants: A systematic review. J Indian Soc Periodontol 2012;16:302-12.
23. Fan T, Li Y, Deng WW, Wu T, Zhang W. Short implants (5 to 8 mm) versus longer implants (>8 mm) with sinus lifting in atrophic posterior maxilla: A meta-analysis of RCTs. Clin Implant Dent Relat Res 2017;19:207-15.
24. Lemos CA, Ferro-Alves ML, Okamoto R, Mendonça MR, Pellizzier EP. Short dental implants versus standard dental implants placed in the posterior jaws: A systematic review and meta-analysis. J Dent 2016;47:8-17.