Original Article

A naïve comparison to assess the success of ultra-short implants

ABSTRACT

Introduction: Conventional implants are associated with ridge augmentation/sinus lift procedures in vertically insufficient ridges, which increase morbidity and healing time. Short implants provided some hope in this context. The present study considered the use of ultra-short implants in vertically insufficient posterior mandibular ridges and evaluated their success. Hence, study was done to evaluate the success of ultra-short implants in partially edentulous posterior mandible clinically and radiographically.

Materials and Methods: The study is a "Naïve direct comparison" of ultra-short implants to conventional implants for assessing their success in vertically insufficient posterior mandibular ridges. A total of 10 ultra-short implants were placed in a partially edentulous posterior mandibular ridge with at least 8-mm horizontal (at crest) and vertical dimensions. A delayed loading was done at three-month follow-up. Data acquisition was done at baseline (immediately after loading), 6-, 9-, 12-month intervals. Parameters assessed were marginal bone loss (MBL), probing pocket depth reduction (PPDR), modified plaque index (mPI), modified gingival index (mGI).

Results: All the placed 10 implants survived, and no failure was observed. "Independent sample *t*-test" and "paired sample *t*-test" was done for intergroup and intragroup analysis, respectively. Intergroup comparison between the ultra-short and conventional implants presented a statistically insignificant difference between all the parameters at all the follow-up visits (baseline, 6-, 9-, 12 months).

Conclusions: Within the limitations, it was thus concluded that ultra-short implants may be considered as a viable treatment option for vertically insufficient mandibular ridge. Further, long-term randomized controlled trials are required to establish the evidence.

Keywords: Extra short implants, implants, short implants, ultra-short implants

INTRODUCTION

Dental implants are every so often used as replacement alternatives for completely or partially edentulous patients.[1] This is often owed to the osseo-integration activity,[2] and the usage of standard dental implants permits a greater area of contact with the bone, which further supports the osseo-integration activity.[3,4] Tooth loss in posterior jaws favor the resorption of bone tissue,[5] resulting in greater immediacy to the inferior alveolar nerve and the maxillary sinus, thus constraining the use of standard or longer dental implants.[3,6] To surmount these issues, bone grafting or lifting the maxillary sinus has been indicated to re-establish the bone height so that the placement of standard dental implants becomes possible. Still, these methods are linked with increased costs, postoperative morbidity, and risk of complications.[5,7] Therefore, short implants are being considered nowadays, which are definitely considered simpler and more cost-effective for rehabilitating atrophic alveolar ridges.[8]

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Received: 25 May 2022, **Revised:** 12 February 2023,
Accepted: 06 April 2023, **Published:** 19 March 2024

Access this article online	
Website: www.njms.in	Quick Response Code
DOI: 10.4103/njms.njms_82_22	

How to cite this article: Barman S, Singh N, Pant VA, Aamir M, Biswas S. A naïve comparison to assess the success of ultra-short implants. Natl J Maxillofac Surg 2024;15:121-30.

Since there is no agreement about the definition of short implants, a few authors classify them to be <10 mm,[9,10] whereas others consider implants ≤8 mm as short implants.[4,11] Also, the present clinical trends consider implants ≤ 6 mm as "extra/ultra-short" implants.[12] There are certain important aspects to implant success and survival. Firstly, the inconsistency in the crown-to-implant (C/I) fraction/ratio may increase the risk of mechanical glitches, but it did not increase the risk of peri-implant marginal bone loss (MBL)[13]; secondly, the consideration of the implant placement site because the probabilities of failure are higher when the implants are placed in the low-density bone, such as in the posterior maxilla.[14] However, there is no agreement on the survival rate of short implants in the posterior mandible or maxilla.[15] Some authors have shown low rates of success,[6,16] while others have found high success rates for the short implants.[17-19] But, on the top of everything, it can be understood that the morbidity associated with ridge augmentation surgery to increase the bone height either above the inferior alveolar nerve or below maxillary sinus is an important issue, which can be effectively managed using short or ultra-short implants.

Also, as per the author's search, data regarding the use and success of ultra-short implants is even sparser than short implants. Hence, the purpose of this clinical study was to assess clinically and radiographically the success of ultra-short implants (5.0 x 5.0 mm) and compare it to that of standard implants (≥8 mm) in the posterior mandible.

MATERIALS AND METHODS

The present study commenced after receiving an ethical clearance from Institutional Ethics Committee (IEC). The study has been approved by the institutional ethical committee vide letter no BBDCODS/01/2019 IEC code 30 dated 10-01-2019. The study design is "Naïve direct comparison" in which only the concerned treatment (i.e., placement of "ultra-short implants in posterior mandible") was done and the results of the present study were compared to the data from previous investigations involving conventional implant placement taken from a systematic review by *Lemos et al. 2016*.[20] Hence, only the *Test group* existed in this report, i.e., ultra-short implant of 5.0 x 5.0 mm was placed in the mandibular posterior edentulous ridge.

The study population included 10 subjects (6 males and 4 females; age range: 25–65 years) each with a partially edentulous posterior mandibular ridge and were enrolled in this study according to a set inclusion and exclusion criterion. *Inclusion criteria*: Systemically and periodontally healthy individuals; a good level of oral hygiene (full mouth plaque and gingival index scores <1); partially edentulous posterior mandibular ridge with at least 8-mm horizontal dimension at the crest; inferior alveolar nerve canal at least 8 mm from the crest of the ridge; presence of antagonist teeth; adequate patient compliance. *Exclusion criteria*: Presence of any systemic illness well-known to affect the normal healing mechanism or bone metabolism; tobacco consumption of any type; immuno-compromised individuals; pregnant and lactating females; individuals on drugs such as anti-epileptics, anti-coagulants, steroids, which are well-known to adversely affect the processes of healing and clotting or cause gingival enlargement.

Prior to enrolling the patients, they were informed of the purpose and design of this clinical study and were required to sign a written informed consent form. A thorough medical and dental history was then taken from each patient and a detailed clinical examination including initial radiographs was performed.

All 10 patients (six males and four females) with partially edentulous posterior mandibular ridges, following an initial examination, diagnosis, and treatment planning were subjected to phase-I therapy, which consisted of full mouth scaling using hand and ultrasonic instruments. Detailed oral hygiene instructions were given to all the patients. Patients were kept on continuous follow-up and re-evaluations every two weeks. Oral hygiene instructions were reinforced on every follow-up appointment until every patient maintained good oral hygiene (full mouth plaque and gingival index score <1).[21,22]

After confirming the suitability of the sites, surgical preparation was done including preoperative mouth rinsing with 1% povidone-iodine solution *(Betadine™)* and facial scrubbing with 2% povidone-iodine solution *(Betadine™)*. Asepsis was maintained throughout the surgical procedure. The area subjected to surgery was anesthetized by inferior alveolar, lingual, and long-buccal nerve blocks using 2% lignocaine with adrenaline at a concentration of 1:200,000 (*Astra Zeneca Pharma India Ltd.)*. A mid-crestal incision was given using #15 BP blade followed by elevation of a buccal and lingual mucoperiosteal flap using Molt's periosteal elevator *(Hu-friedy™)*, which gave direct visual access to the surgical site. [Figure 1]

Bicon® Implant System: Bicon® provides a very distinctive and comprehensive short-implant system ever since 1985. As per the claim of Bicon®, this system is characterized by three unique design patterns.

1. *Unique Plateau* improves the use of short implants.
2. *Bacterially Sealed Locking Taper Implant-abutment Connection* provides 360° of universal abutment positioning thus offering restorative flexibility.

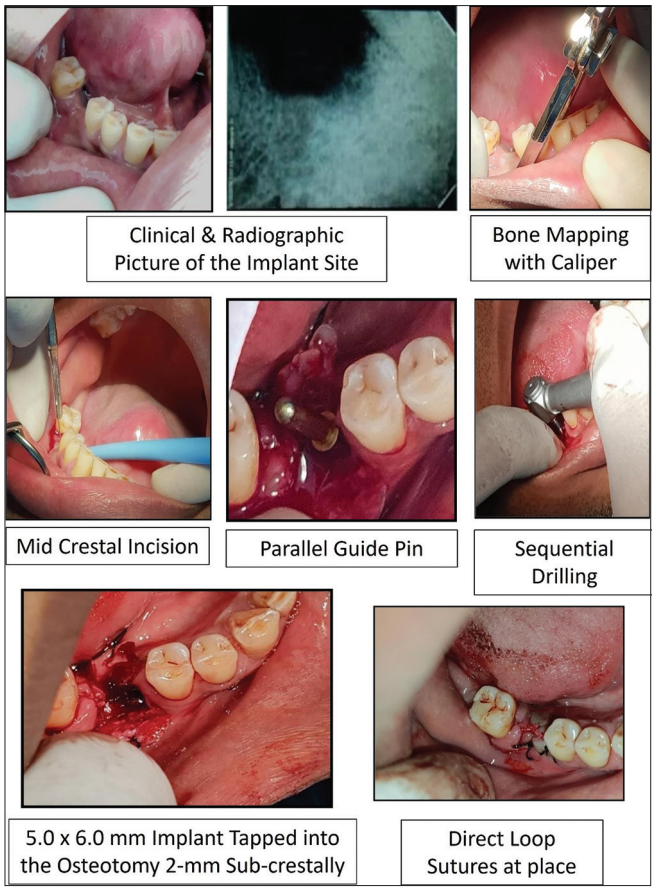

Figure 1: Surgical Procedure

3. *Sloping Shoulder*, which may promote aesthetically pleasing gingival-restoration inter-relationship because the bone that is maintained over the shoulder of the implant provides support for the interdental papillae.

Osteotomy drilling commences with a 2-mm pilot hole with external irrigation to a depth 2–3 mm deeper than chosen implant size if anatomy allows. An abutment with a 2-mm post was inserted into the pilot hole and the correctness was verified with a vacuum press template. Next, the osteotomy was widened with sequential reamers/drills without irrigation at 50 rpm maximum speed. In this report, a 5.0 x 5.0 mm implant has been selected so the diameter of the final drill was 5 mm. Autogenous bone inadvertently and intermittently removed/harvested from the flutes of the reamers during drilling was placed into a silicone dappen dish for later use. Bone could also be harvested from the walls of prepared osteotomy. The sterile blister pack of implant was dropped onto a sterile tray before removing its Tyvek® backing. Then, the implant's inner packaging is cut with a pair of scissors.

Implant was then removed from the polybag and settled by softly tapping on the healing plug with an appropriate seating tip into the osteotomy to eventually achieve a *2-mm subcrestal* position following which the healing plug is cut and checked for any sharp edges. Harvested bone graft was then condensed over the shoulder of the implant. Now, the flaps were repositioned and sutured to achieve a primary soft tissue closure with non-resorbable 3-0 silk sutures *(Ethicon, Johnson and Johnson, Somerville, NJ, USA)* using a direct loop technique. After implant insertion, an immediate postoperative radiograph was performed.

For post-surgical care, each patient was kept under an antibiotic coverage *(Amoxicillin-CV 625 mg BD 5-days)*. Postoperative pain and oedema were controlled by prescribing a *Diclofenac potassium 50 mg BD 5-days*. Chlorhexidine mouth rinse (0.2%, 12 hourly for four weeks post-surgery) was prescribed to the patient. Also, the patient was refrained from tooth brushing, flossing, and other interdental cleaning aids in the surgical area for one-week post-surgery.

Post-Surgical Follow Up and Maintenance

Sutures were removed one-week post-surgery. The surgical wound was then gently cleansed with 1% povidone-iodine solution. Each patient was instructed to initiate mechanical oral hygiene, consisting of gentle tooth brushing using Charter's technique with a soft toothbrush and not use any type of interdental cleaning aids in the treated area for a period of four weeks post-surgery.

Recall appointments were scheduled for re-evaluation at two weeks, one, and three months post-surgery. Postoperative care also included the reinforcement of oral hygiene instructions at each appointment and in-office plaque removal when- and wherever necessary.

The implants were uncovered after three months of healing period. Temporary abutments were placed, flaps were readapted, and sutures were placed around the temporary abutments. Definitive impressions were made after three weeks of soft tissue healing. Porcelain fused to metal crowns were delivered [Figure 2], following which all patients were recalled at 6, 9, and 12 months for data recording. Oral hygiene reinforcements, in-office deplaquing, occlusal adjustments were made, and prosthetic restorations were checked for loosening, chipping, or other prosthetic complications at each recall appointment thereafter.

Study parameters and outcomes

Upon completion of the loading following clinical and radiographical parameters were assessed at

baseline (immediately after loading), 6, 9, and 12 months post-loading.

- *Modified PI (mPI$_b$ mPI$_6$ mPI$_9$ and mPI$_{12}$)* by Mombelli *et al.* 1987[23]
- *Modified GI (mGI$_b$, mGI$_6$ mGI$_9$ and mGI$_{12}$)* by Mombelli *et al.* 1987[23]
- *Probing Pocket Depth Reduction- PPDR (PPDR$_b$ PPDR$_6$ PPDR$_9$ and PPDR$_{12}$)*

Probing pocket depth was determined by using UNC-15 graduated plastic periodontal probe, *Hu-friedy,* and we recorded to the nearest mm taking the gingival margin as reference. All the six sites (mesiobuccal, mid-buccal, distobuccal, mesiolingual, mid-lingual, and distolingual) per implant were examined for PPD and the site with the deepest findings was included in the study. Subtracting the PPD at recent follow-up from the previous follow-up from the recent one gave the clinical outcome—"*PPDR*."

Customized acrylic stents were not used for the reproducibility of the probing angulation as there are certain drawbacks of stent usage. Stents are usually stored for about six months or more, and the stents, in most of the cases, are made up of self-cure acrylic resins which have a greater dimensional instability as compared to heat-cure acrylic (due to higher residual free monomer ratio of 3–5% in self-sure acrylic as compared to 0.2–0.5% in heat-cure acrylic). Using a heat-cure acrylic to prepare occlusal stents is clinically impractical. Hence, self-cure acrylic stents usually get distorted on storage for a long-time span (≥6 months) changing the adaptation of the stent on the occlusal surface which further changes the probing angulation thus hampering the standardization.[24]

Marginal Bone Loss- MBL (MBL$_b$, MBL$_6$, MBL$_9$ and MBL$_{12}$)

An Intra-oral peri-apical (IOPA) image was captured with paralleling technique (owing to its reproducibility) using *Unicorn RVG sensor, Geno-ray Portable Xray Unit X-II, XCP RVG-sensor Positioner, and a Grid.* For reproductibility of bite at one year, we used a "Polyether bite registration paste" for every case (owing to its long-term stability). Images obtained were analyzed for radiographic parameter—"*Marginal bone level*" at baseline, 3, 6, 9, and 12 months.

The coronal surface of the implant (yellow line) was taken as the reference line from which two perpendicular lines (red lines) were dropped on the mesial and distal aspect of the implants to the first bone-to-implant contact [Figure 3]. Comparative measurements of mesial and distal crestal bone levels adjacent to implants were made to the nearest 0.1 mm. A minimum of three readings were made for each case and the average values were calculated. Subtracting the bone level at previous follow-up from the recent one gave the radiographic outcome—"*Marginal Bone Loss*."

RESULTS

All patients finished the study and no dropouts have occurred. Healing was uneventful in every case and site. A total of 10

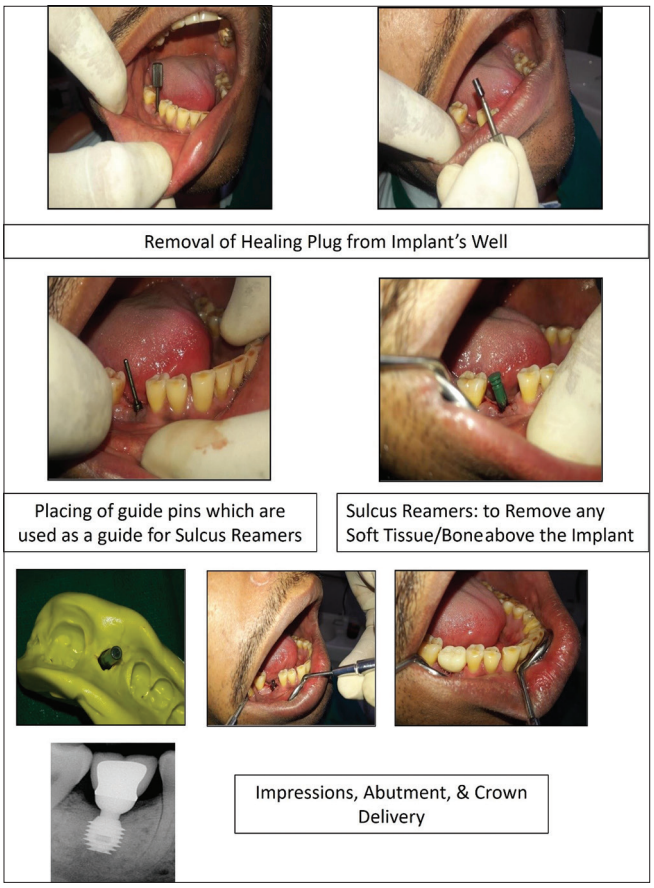

Figure 2: Restoration

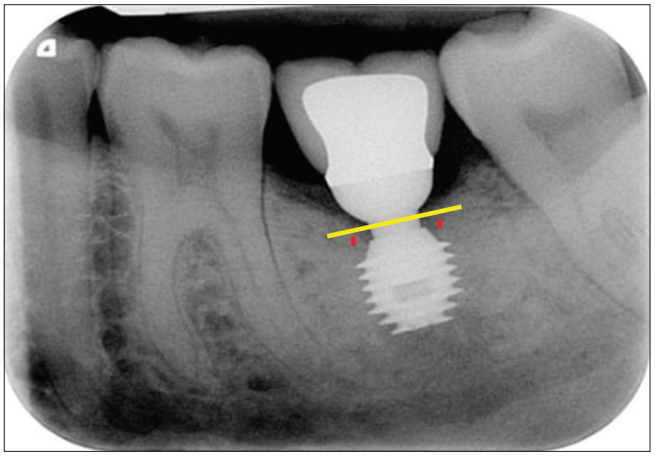

Figure 3: Measurement of Marginal Bone Loss (MBL)

ultra-short implants (5.0 x 5.0 mm) were placed in patients of either gender, >18 years of age, having partially edentulous posterior mandibular ridge with at least 8-mm horizontal dimension at crest and 8-mm dimension from crest to the superior border of the inferior alveolar canal. As the present study is a Naïve Direct Comparison, the test group was formed with the patients who underwent ultra-short implants in the posterior mandibular arch and the data from previous studies[20] regarding the conventional implants in posterior mandibular arch was considered as the control group.

The clinical and radiographic parameters were assessed at baseline (immediately after loading), 6, 9, and 12 month follow-up visits around all the ultra-short implants. The parameters (both clinical and radiographic) at the implant sites in both the groups presented a statistically insignificant difference at baseline ($P > 0.05$). Hence, they did not affect the outcomes.

Tables 1-4 represent the *inter-group comparison of the study parameters*. "Independent sample *t*-test" was used for intergroup analysis. Marginal bone loss, PPDR, mean differences in mPI, and mGI scores at all the time periods of data acquisition, i.e., at baseline (immediately after loading), 6, 9, and 12 months were found to be statistically insignificant ($P > 0.05$) when compared between the groups. Tables 5-8 represent the *intra-group comparison of the study parameters* (MBL, PPDR, mPI, mGI,) at all the time periods of data recording. "Paired sample *t*-test" was used for intragroup analysis.

Intragroup comparison

Marginal Bone Loss (MBL) [Table 5]

With respect to marginal bone loss at the four time periods of data acquisition, in ultra-short implant group, the MBL was found to be statistically significant at nine months ($P = 0.003$) and 12 months ($P = 0.009$) when baseline data was considered for the comparison. Also, statistically significant MBL was found between 6 and 9 months ($P = 0.047$) and between 6 and 12 months ($P = 0.009$). The MBL between baseline and 6 months ($P = 0.221$), and between 9 and 12 months ($P = 0.758$) were statistically insignificant.

In conventional implant group also, the MBL was found to be statistically significant between baseline and 9 months ($P = 0.048$), between baseline and 12 months ($P = 0.035$), between 6 and 9 months ($P = 0.05$), and between 6 and 12 months ($P = 0.043$). Marginal bone loss between baseline and 6 months ($P = 0.678$) and between 9 and 12 months ($P = 0.591$) are statistically insignificant.

Probing Pocket Depth Reduction (PPDR) [Table 6]

With respect to PPDR at the four time periods, in ultra-short implant group, it was found to be statistically significant between baseline and 6 months (p = 0.013), between baseline and 9 months ($P = 0.003$) and between baseline and 12 months ($P = 0.001$). The PPDR was found to be statistically insignificant from 6 to 9 months ($P = 0.758$), 6 to 12 months ($P = 0.081$) and 9 to 12 months ($P = 0.10$).

In conventional implant group also, the difference in mean PPDR was found to be statistically significant between baseline and 6 months ($P = 0.001$), between baseline and 9 months ($P = 0.013$) and between baseline and 12 months ($P = 0.007$). The PPDR was statistically insignificant from 6 to 9 months ($P = 0.394$), 6 to 12 months ($P = 0.642$) and 9 to 12 months ($P = 0.096$).

Modified Plaque Index (mPI) [Table 7]

With respect to changes in mPI at the four time periods, in ultra-short implant group, a statistically significant reduction was found between baseline and 6 months, baseline and 9 months and baseline and 12 months ($P < 0.001$). Beyond 6 months, the reduction in mPI was found to be statistically significant from 6 to 9 months ($P = 0.007$), from 6 to 12 months ($P = 0.001$) and from 9 to 12 months ($P = 0.010$).

Table 1: Comparison of Ultra-short and Conventional Implant Groups at the follow- up periods with respect to MBL

Parameter	Follow up period	Implant	Mean	Std. Deviation	Mean difference	*P*
MBL	Baseline	Short	0.26	0.14	0.06	0.380, NS
		Conventional	0.32	0.15		
	6 months	Short	0.21	0.07	0.09	0.088, NS
		Conventional	0.3	0.13		
	9 months	Short	0.15	0.11	0.02	0.665, NS
		Conventional	0.17	0.09		
	12 months	Short	0.14	0.05	0.01	0.777, NS
		Conventional	0.15	0.09		

P<0.05 is considered statistically significant, *P*-value: Probability value; NS: Not Significant; MBL: Marginal bone loss

Table 2: Comparison of Ultra-short and Conventional Implant Groups at the follow- up periods with respect to PPDR

Parameter	Follow up period	Implant	Mean	Std. Deviation	Mean difference	*P*
PPDR	Baseline	Short	4.93	0.37	-0.07	0.671, NS
		Conventional	5.00	0.35		
	6 months	Short	4.80	0.41	-0.03	0.868, NS
		Conventional	4.83	0.39		
	9 months	Short	4.81	0.41	-0.05	0.791, NS
		Conventional	4.86	0.42		
	12 months	Short	4.74	0.42	-0.07	0.723, NS
		Conventional	4.81	0.45		

P<0.05 is considered statistically significant, *P*-value: Probability value; NS: Not Significant; PPDR: Probing pocket depth reduction

Table 3: Comparison of Ultra-short and Conventional Implant Groups at the follow- up periods with respect to mPI (Mombelli *et al*. 1987)

Parameter	Follow up period	Implant	Mean	Std. Deviation	Mean difference	*P*
mPI	Baseline	Short	0.68	0.18	0.12	0.132, NS
		Conventional	0.56	0.16		
	6 months	Short	0.44	0.13	0.09	0.117, NS
		Conventional	0.35	0.11		
	9 months	Short	0.33	0.17	0.07	0.229, NS
		Conventional	0.26	0.05		
	12 months	Short	0.24	0.12	0.04	0.361, NS
		Conventional	0.20	0.07		

P<0.05 is considered statistically significant, *P*-value: Probability value; NS: Not Significant; mPI: Modified plaque index

Table 4: Comparison of Ultra-short and Conventional Implant Groups at the follow- up periods with respect to mGI (Mombelli *et al*. 1987)

Parameter	Follow up period	Implant	Mean	Std. Deviation	Mean difference	*P*
mGI	Baseline	Short	0.70	0.48	0.10	0.628, NS
		Conventional	0.80	0.42		
	6 months	Short	0.20	0.42	0.10	0.628, NS
		Conventional	0.30	0.48		
	9 months	Short	0.20	0.42	0.00	1.00, NS
		Conventional	0.20	0.42		
	12 months	Short	0.30	0.48	0.30	0.065, NS
		Conventional	0.00	0.00		

P<0.05 considered statistically significant, *P*-value: Probability value; NS: Not Significant; mGI: Modified gingival index

Table 5: Assessment of changes in MBL at the follow-up periods between Ultra-short and Conventional Implant groups

Parameters	Pairs	Short		Conventional	
		Mean difference	*P*	Mean difference	*P*
MBL	Baseline vs 6 months	0.05	0.221, NS	0.02	0.678, NS
	Baseline vs 9 months	0.11	0.003, S	0.15	0.048, S
	Baseline vs 12 months	0.12	0.009, S	0.17	0.035, S
	6 months vs 9 months	0.06	0.047, S	0.13	0.050, S
	6 months vs 12 months	0.07	0.009, S	0.15	0.043, S
	9 months vs 12 months	0.01	0.758, NS	0.02	0.591, NS

P<0.05 is considered statistically significant, *P*-value: Probability value; S: Significant NS: Not Significant; MBL: Marginal bone loss

In conventional implant group also, the decrease in mPI was found to be statistically significant from baseline to 6 months, from baseline to 9 months and from baseline to 12 months ($P < 0.001$). Beyond 6 months, the decrease in mPI was found to be significant from 6 to 9 months ($P = 0.019$), from 6 to 12 months ($P = 0.007$) and from 9 to 12 months ($p = 0.024$).

Modified Gingival Index (mGI) [Table 8]

With respect to the changes in mGI at the four time periods, in ultra-short implant group, a statistically significant reduction was depicted from baseline to 9 months ($P = 0.015$) and baseline to 12 months ($P = 0.037$). The decrease in mGI

Table 6: Assessment of changes in Probing Pocket Depth (PPD) at the follow-up periods in Ultra-short and Conventional Implant groups

Parameters	Pairs	Short		Conventional	
		Mean difference	*P*	Mean difference	*P*
PPD	Baseline vs 6 months	0.13	0.013, S	0.17	0.001, S
	Baseline vs 9 months	0.12	0.003, S	0.14	0.013, S
	Baseline vs 12 months	0.19	0.001, S	0.19	0.007, S
	6 months vs 9 months	-0.01	0.758, NS	-0.03	0.394, NS
	6 months vs 12 months	0.06	0.081, NS	0.02	0.642, NS
	9 months vs 12 months	0.07	0.10, NS	0.05	0.096, NS

P<0.05 is considered statistically significantm, *P*-value: Probability value; S: Significant; NS: Not Significant; PPDR: Probing pocket depth reduction

Table 7: Assessment of changes in mPI at the follow-up periods in Ultra-short and Conventional Implant groups

Parameters	Pairs	Short		Conventional	
		Mean difference	*P*	Mean difference	*P*
mPI	Baseline vs Baseline	0.63	0.001, S	0.85	0.001, S
	Baseline vs 6 months	0.87	*P*<0.001, HS	1.06	*P*<0.001, HS
	Baseline vs 9 months	0.98	*P*<0.001, HS	1.15	*P*<0.001, HS
	Baseline vs 12 months	1.07	*P*<0.001, HS	1.21	*P*<0.001, HS
	Baseline vs 6 months	0.24	0.001, S	0.21	0.001, S
	Baseline vs 9 months	0.35	*P*<0.001, HS	0.30	*P*<0.001, HS
	Baseline vs 12 months	0.44	*P*<0.001, HS	0.36	*P*<0.001, HS
	6 months vs 9 months	0.11	0.007, S	0.09	0.019, S
	6 months vs 12 months	0.20	0.001, S	0.15	0.007, S
	9 months vs 12 months	0.09	0.010, S	0.06	0.024, S

P<0.05 is considered statistically significant, *P*-value: Probability Value; S: Significant; NS: Not Significant; mPI: Modified plaque index

Table 8: Assessment of changes in mGI at the follow-up periods in Ultra-short Conventional Implant groups

Parameters	Pairs	Short		Conventional	
		Mean difference	*P*	Mean difference	*P*
mGI	Baseline vs 6 months	0.50	0.052, NS	0.50	0.015, S
	Baseline vs 9 months	0.50	0.015, S	0.60	0.005, S
	Baseline vs 12 months	0.40	0.037, S	0.80	0.001, S
	6 months vs 9 months	0.00	1.00, NS	0.10	0.591, NS
	6 months vs 12 months	-0.10	0.591, NS	0.30	0.081, NS
	9 months vs 12 months	-0.10	0.678, NS	0.20	0.168, NS

P<0.05 is considered statistically significant, *P*-value: Probability value; S: Significant; NS: Not Significant; mGI: Modified gingival index

scores between the other follow-up periods was found to be statistically insignificant.

In conventional implant group also, the decrease in mGI was found to be statistically significant from baseline to 9 months ($P = 0.015$) and baseline to 12 months ($P = 0.037$). The decrease in mGI scores between the other follow-up periods was found to be statistically insignificant.

Modified gingival index and mGI scores remained <1 throughout the study period indicating that all the patients included in the study maintained good oral hygiene levels.

Thus, with respect to MBL, PPDR, mPI, and mGI, the changes in mean values in ultra-short implant group and in conventional implant group at all the time periods were found to be statistically similar.

DISCUSSION

The objective of this naïve direct comparison was to analyze and compare the clinical success of single ultra-short implant in the mandibular posterior alveolar ridge to single conventional ones in the same area (data of which taken from past research). Since the design of the present study, heterogeneity at baseline (immediately after loading) for clinical and radiographic parameters may be attributed to the different treatments and population selected.

The definition of short implants is still under controversy. Implants <11, 10, or 8 mm were defined as short implants.[4,25,26]

In the present report, 5.0 x 5.0 mm implants were used and considered as ultra-short implants.[12] In a systematic review, *Lemos et al. (2016)*[20] stated that a statistically insignificant difference was found regarding MBL, implant survival, prosthesis failures, and other complications between short (8 mm) and conventional implants. Authors concluded that short implants may be considered as a viable and predictable treatment option for posterior jaws. Though, they also asserted that short implants with length <8 mm (4–7 mm) should be cautiously used as they present with higher risks of failures.[20] These results are in harmony with the recent studies presenting high success and survival rates for short implants.[18,19,27,28] In a prospective five-year follow-up clinical study of 6-mm implants, a survival rate of 95% was reported.[18] The present study reported a 100% survival rate of 10 ultra-short implants (5.0 x 5.0 mm) and a statistically insignificant ($P \geq 0.05$) difference was found when compared with conventional implants (data from previous studies)[20] over a total follow-up time of 12 months. These results were in accordance and even better to previous studies[29-41] showing a mean survival rate of short implants (8 mm) was 96.13% and that of conventional implant was 97.28%.

In this report, mean MBL, at baseline (immediately after loading), 6, 9, and 12 months for ultra-short implants noted as 0.68 ± 0.18, 0.44 ± 0.13, 0.33 ± 0.17, and 0.24 ± 0.12 mm. There was a statistically insignificant ($P \geq 0.05$) difference in between ultra-short implants and conventional implants (from previous studies) which was in accordance with previous data.[29,30,32-39] Certain reports also presented with significantly less MBL in case of short implants compared to standard counterparts. The reason explained by these researchers was the significant effect of wider diameter of short implants.[42] Same can be the reason for less MBL in this study as the diameter of implants selected was 5 mm. Moreover, in the present study we submerged the ultra-short implants 2 mm below the bone crest which may have further reduced the MBL. This was in accordance with the previous human prospective comparative study by Chover and Diago *et al*. 2016,[43] in which they found a mean bone loss of 1.13 mm and 0.57 mm in crestally and subcrestally placed implants, respectively. They concluded that placing implants subcrestally increases the amount of bone loss, but the final position of the marginal bone loss remains crestal to implant platform, which is favorable for peri-implant health.

Regarding, postoperative complications, no implant mobility, adverse tissue responses, infections, or unusual patient experiences were noticed. Previous studies[29,32-38] presented with higher complication rates of standard implants especially in complicated situations where vertical dimension of available bone needs bone grafting or sinus augmentation procedures for implant installation. Less complications are noted in short implant cases in these situations where an insufficient vertical dimension of bone is present. An ultra-short implant thus even better

- *avoids vital structures,*
- *minimize bone grafting procedures and its associated morbidity,*
- *maximize implant placement possibilities,*
- *increase patient acceptance and cost-effectiveness,*

Hence, these implants may simplify healing as seen in the present report with 5-mm implant. Present study has evaluated implant mobility by the standard mobility assessment procedure using the blunt end of two mouth mirrors. Resonance frequency analysis (RFA) device was not used to assess the mobility due to unimodule design of the *Bicon® Short Implants* where RFA device can't be attached.

The effects of C/I ratio were not evaluated in this report. Although biomechanical studies have reported that higher C/I ratio may increase the MBL, this unfavorable effect has not been observed in clinical studies.[8,13,44,45] In a systematic review, Quaranta *et al*.[13] reported that the C/I ratio cannot be considered as a risk factor for biological complications around dental implants and implant failure.

Secondary objective of this report was to compare soft tissue parameters between two implant systems (ultra-short implants from present study and standard implants from previous research). These soft tissue parameters represent essential elements of implant diagnostics and have been included in the success criteria of implants. However, a recent review reported that periodontal indices such as mGI, mPI, and PPD are irrelevant diagnostic tools in the evaluation of implants and that these should be avoided, as they cause unnecessary trauma to the peri-implant tissues.[46] In this clinical study, statistically insignificant differences were found in terms of soft tissue parameters between ultra-short and standard implants (from previous studies). Additionally, these measurements did not traumatize or affect the peri-implant tissues. Comparing these results with existing literature is quite difficult, since most clinical studies do not report soft tissue outcomes.

Shortcoming of the present report was the small sample size of only 10 ultra-short implants which further reduce the power of the study. Moreover, C/I ratio and RFA quotient was not considered in the present report as comparison

parameters. Hence, authors suggest further randomized controlled clinical trials with larger sample sizes to assess the predictability and stability of the 5.0 x 5.0-mm ultra-short implants.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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