Received: 15 August 2017 | Revised: 11 November 2017 | Accepted: 13 November 2017

DOI: 10.1111/cid.12568

ORIGINAL ARTICLE

WILEY

A prospective, multi-center study assessing early loading with short implants in posterior regions. A 3-year post-loading follow-up study

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Abstract

Background: Few prospective studies about early loading of short implant have been available and very little evidence exists on the outcomes longer than 3 years.

Purpose: To assess clinical and radiographic outcomes of 6 mm-short implants placed in the posterior maxilla and mandible applying an early loading protocol.

Materials and methods: Ninety-five short implants (6 mm-short, Ø 4 mm) were placed in 45 subjects at 3 study sites, 2 or 3 implants per subject, using a one-stage surgical procedure and loaded with a screw-retained splinted fixed prosthesis 6 weeks later. Follow-up took place at 6, 12, 24, and 36 months after loading. Marginal bone level changes, implant survival, clinical variables, and adverse events were assessed.

Results: The survival rate for all implants placed was 95.8%. From implant loading to 3 years follow-up, mean marginal bone level changes were minimal (0.07 ± 0.49 mm) and the peri-implant soft tissue status was healthy. No major technical or biological complications occurred except for the 4 early implant losses.

Conclusion: Three-year data indicates that the use of splinted 6 mm-short implants is a viable treatment in posterior regions with low marginal bone resorption. Early loading after 6 weeks should be taken cautiously in patients with known risk factors.

KEYWORDS

early loading, marginal bone loss, posterior jaws, short implant

1 | INTRODUCTION

The use of short implants in the posterior regions of jaws, where there is a lack of sufficient bone volume, has become a growing interest among clinicians. Instead of using different challenging surgical techniques such as bone augmentation, or intra- or para-sinus procedures, the advantage of using short implants is a reduction in the number of treatment procedures, treatment time, morbidity, and cost.

The classification of "short implant" lengths in the existing literature is varied and several studies and reviews include implant lengths of up to 10 mm in the short category. But a more strict definition of short implants indicates a length of $\leq$8 mm.[1] Encouraging survival rates have been reported over time. Recent systematic reviews indicated that short implants have the same survival rates and degree of marginal bone loss as longer implants.[2,3] Severely reduced bone height in posterior areas limits the use of short implants, creating a need for even shorter implants, that is implants $\leq$6 mm. The term "ultrashort" was introduced to describe them.[4] Some literatures have evaluated the performance of implants $\leq$6 mm long.[5–9] However, few prospective studies have been available and very little evidence exists on the outcomes longer than 3 years.[9–13] Moreover, wide heterogeneity occurs regarding implant diameter, loading protocol, superstructures type, and length in various studies.

Successful early loading of dental implants was first described in 1990s. Since then, several studies have confirmed that using early loading protocols for dental implants can have high survival rates and good clinical outcomes.[14–18] However, whether the early loading protocol can be used routinely remains unclear. This is particularly so in the posterior jaws, where the occlusal forces are much higher than in the anterior jaws; or with the short implants, which have less part engaged in bone. Limited literature can be found for the short implant in an early loading protocol.[13,19–22] Consequently, traditional loading remains the choice of most clinicians.

This study was designed as a prospective, multicenter study, evaluating the use of 6 mm-short and 4 mm-wide OsseoSpeed TX implants placed in the posterior maxilla and mandible, applying an early loading protocol with splinted fixed dental prostheses. The primary objective was to evaluate marginal bone level alterations in the course of 3 years after loading. The secondary objectives were to evaluate implant survival rates, condition of the peri-implant mucosa, pocket depths, and safety in a Chinese population.

2 | MATERIAL AND METHODS

Three centers in China participated in this clinical study. At each center, up to 3 clinicians performed the surgery and clinical observations. All 3 centers adopted the same eligibility criteria and clinical variables. Prior to the commencement of the study, a meeting was held and appropriate relevant training was given to all investigators.

2.1 | Patient population size and selection

This was an observational study. As no hypothesis was planned to be tested, a formal sample size calculation was not performed. However, based on earlier studies[16,23] it was estimated that 15 patients in total (5 in each center) should be enough to study changes over the time from baseline until consecutive visits. To further increase the precision of the studied variables and to compensate for possible patients dropping out during the long-term follow-up, it was decided to recruit 15 patients per center, a total of 45 subjects in the study.

The screening procedure included a clinical and radiographic (Cone Beam Computed Tomography) examination, and full-mouth periodontal evaluation. Subjects were recruited according to the inclusion and the exclusion criteria specified in Table 1. The first patient was enrolled in February 2011 and the last patient in February 2012. All subjects were informed orally and in writing about the study and signed the informed consent form before study start. All patients received appropriate periodontal dental treatment before implant installation. The study protocol had been approved by the medical ethics committee of Peking University Medical Center.

2.2 | Treatment procedure

2.2.1 | Surgical procedures

Implant surgery was performed following a standard one-stage protocol, according to the manufacturer. The surgical procedure was performed under local anesthesia. After a crestal incision and reflection of buccal and lingual/palatal flaps, two or three OsseoSpeed TX implants, (Astra Tech Implant System UniAbutments, Dentsply Sirona Implants, Mölndal, Sweden) 6 mm in length with a diameter of 4 mm were placed in each patient. In cases of a small dehiscence, autologous bone particles, harvested in the bone area close to the implant site, could be used. No other graft material was allowed. A healing abutment was screwed onto the implant, and the flaps were repositioned and sutured to allow a transmucosal healing during the 6-week healing period. Primary implant stability was assessed clinically through torque insertion measurements at placement. Primary implant stability was reached if the insertion torque was more than 15 Ncm. In cases where primary implant stability was not reached (less than 15 Ncm), the patient was

TABLE 1 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
1. Aged 20–75 years at enrolment;	1. Earlier graft procedures in the study area;
2. In need of 2–3 implants in the posterior area of the upper or lower jaw;	2. Current need for presurgical bone or soft tissue augmentation in the planned implant area;
3. History of edentulism for at least 4 months;	3. Uncontrolled pathologic processes in the oral cavity, including untreated acute and chronic periodontal disease;
4. Presence of natural teeth, partial prosthesis and/or implants in the opposite jaw in contact with the planned implants;	4. Systemic or local disease or condition that could compromise postoperative healing and/or osseointegration;
5. Presence of natural tooth root(s) adjacent to the planned implants;	5. History of chemotherapy within 5 years prior to surgery;
6. The bone height and width of the implant sites at least 6 mm assessed by CBCT;	6. History of radiation therapy in the head and neck region;
7. Deemed by the investigator to present an initially stable situation.	7. Corticosteroids or any other medication that could influence postoperative healing and/or osseointegration;
	8. Uncontrolled diabetes mellitus;
	9. Smoking more than 10 cigarettes/day;
	10. Present alcohol and/or drug abuse and pregnancy.

treated with a conventional two-stage approach (ie, submerged healing in combination with an extended healing period of 3 months before loading of the implants). Corticosteroids or any other medication that could influence postoperative healing and/or osseointegration were to be avoided during the study period. Postoperative treatment included a 0.12% chlorhexidine rinse twice daily for 14 days. Other medications, which were considered necessary for the subject's safety and well-being, could be given at the discretion of the investigators. For example amoxicillin (erythromycin if allergic to penicillin) were prescribed to all patients according to routine postoperative standard of care. The patients were instructed to avoid chewing at the operated side and advised to use a soft diet from implant placement (IP) until the delivery of the provisional prosthetic restoration, this to avoid excessive loading of the implants during the initial healing period.

2.2.2 | Prosthetic procedures

One week after IP, a follow-up visit was scheduled for suture removal and review of the healing process. UniAbutments were connected and impressions at the abutment level were made for fabrication of the screw-retained temporary splinted polymer-ceramic crowns, which was delivered 6 weeks following IP in full functional occlusion (Figure 1A). The definitive screw-retained splinted porcelain fused to metal crowns were delivered 6 months after loading with the provisional prosthesis and then followed up to 3 years (Figure 1B). In cases where osseointegration was not achieved at 6 week or in cases of postponed loading due to any other reason, patients were not excluded from the study, but followed up for the full course of the study and included in the safety analysis. However, all these implants that could not be loaded at 6 week post-surgery were excluded from the Per Protocol analysis.

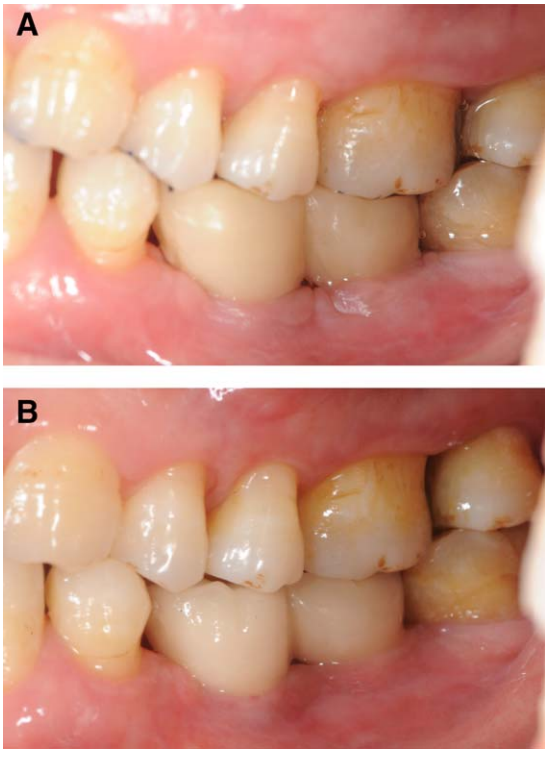

FIGURE 1 Clinical views of a case. A, Lateral view at the time of provisional splinted crown delivery, 6 weeks after implant placement. B, Lateral view after 3 years of follow-up

2.2.3 | Clinical examination

An oral examination evaluating the presence of plaque, probing pocket depth (PPD) and bleeding on probing (BOP) was performed 6 weeks after IP, when temporary restorations were loaded (ie, base line), and at 1, 6, 12, 24, and 36 months after baseline. The presence of plaque, PPD, and BOP were scored at 4 sites for each implant (mesial, distal, buccal, lingual/palatal). Implant stability was evaluated manually by means of tweezers. If presence of plaque was noted, the subject was reinstructed in oral hygiene. Periodontal prophylaxis was carried out for each case at each visit. Full-mouth periodontal chartings were recorded once again at the 3-year-visit. Adverse events and adverse device effects were recorded throughout all the visits.

2.2.4 | Radiographic evaluation

At 6 weeks when the provisional prosthesis was placed, and at 6 months, 1-, 2-, 3-years after loading, standardized digital peri-apical radiographs were taken with paralleling technique using film holders (Figure 2A-F). To minimize the risk of radiographic error, the threaded profile of the implant, both mesially and distally, had to be clearly visible in the radiograph. Marginal bone levels were determined from digital radiographs and expressed as the distance from a reference point on the implant (ie, the junction of the machined bevel and the start of the micro-thread) to the most coronal bone-to-implant contact on the mesial and distal aspect of the implant. Digital radiographs were displayed and measured in appropriate software and the distance was recorded to the nearest 0.1 mm. In cases where the implant reference point was below the margin of the crestal bone, the value was considered as zero. Marginal bone level change (MBLC) was presented as the difference in bone levels at distal and mesial aspects of the implant from IP to 6 months, 1-, 2-, and 3-years post loading. An external, independent radiologist from the University of Gothenburg in Sweden evaluated all the radiographs. The precision measurement of radiological analyses was not done in this study; however, it has already been done in one of their previous studies,[24] in which the mean difference between 2 readings was only 0.04 mm.

2.3 | Statistical analysis

The main analysis was performed on MBLC 3 years after implant loading. Data was summarized using descriptive and inferential methods for example subject number, mean, median, standard deviation/standard error, range, frequency tables, and confidence intervals. The MBLC were analyzed with regards to upper versus lower jaws and the Mann-Whitney *U* test was performed to test for the intergroup differences. For continuous data, a mean value was calculated per patient. Thus, probing depths were presented as the mean of all measurements on four sides of the implant. For categorical data, such as bleeding, a patient was considered as "bleeding" if at least one site was "bleeding,"

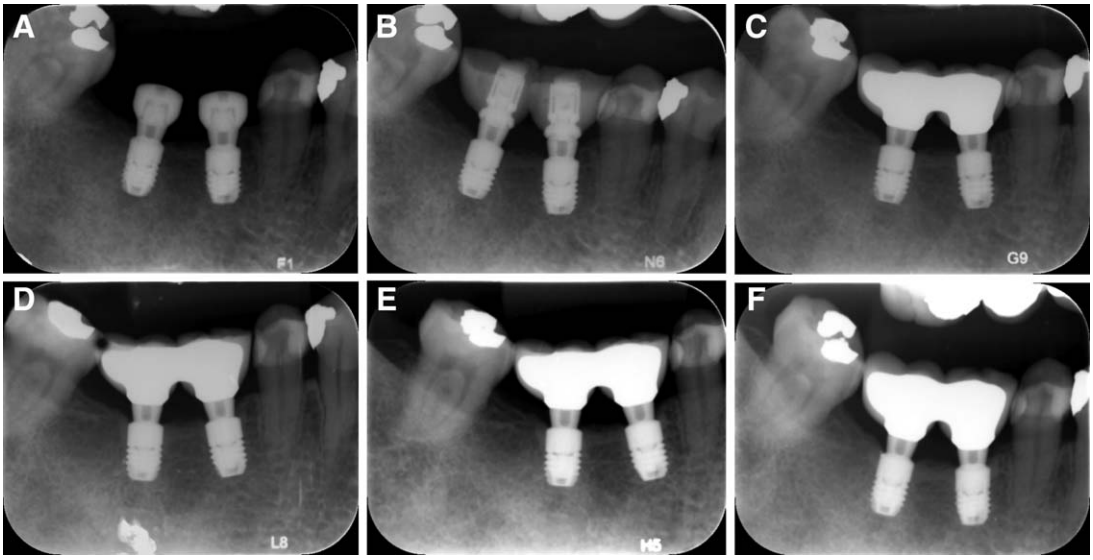

FIGURE 2 Radiographic documentation of A, OsseoSpeed implant, UniAbutment and Healing Cap after implant placement; B, at provisional prosthesis delivering (loading baseline); C, at definitive porcelain fused to metal prosthesis delivery (6 months after loading); D, at the 1-year follow-up; E, at the 2-year follow-up; F, at the 3-year follow-up

otherwise the patient was considered as "nonbleeding." A *P* value below .05 was considered as statistically significant. The statistical software packages used were IBM SPSS Statistics for Windows, Version 22.0 (SPSS Inc, Chicago, Illinois), and Microsoft Excel 2010.

3 | RESULTS

According to the inclusion and exclusion criteria, a total of 45 subjects (17 men and 28 women, mean age 53 years, range 26–73 years) were included in the study (Table 2). In total, 95 implants were placed following the manufacturer's guideline. Sixty-four implants were placed in the mandible and 31 were placed in the maxilla. None of the IPs required a sinus lift. All placed implants were planned for splinted crown restorations. One implant in the study was followed up as single crown restoration due to 1 of 2 placed implants lost at impression. Forty patients (88.9%) were nonsmokers, 3 patients were ex-smokers, 1 patient was a habitual smoker, and one was an occasional smoker. Thirty-six subjects (80.0%) were diagnosed with periodontitis, including 33 with chronic periodontitis and 3 with aggressive periodontitis. The other 9 patients were periodontal healthy. Forty-four patients completed the 3-year evaluation period except one patient that passed away before the 3-year follow-up due to cancer. The patient characteristics of Per Protocol subjects/implants are shown in Table 2 as well.

3.1 | Implant survival

Any removed implant was considered as a failure, regardless reason(s) for removal. Primary stability was achieved in 95.8% (91/95) of the implants during surgery. At 5 weeks after surgery, at the time of impression taking, 4 implants were removed because of obvious mobility and 1 implant rotated when removing the UniAbutment carrier. After prolonging the healing period to 5 months, the rotated implant achieved osseointegration and a final restoration was delivered. No implant was lost after loading resulting in a cumulative implant survival rate of 95.8%. The 4 implants that were lost had been placed in the lower left quadrant (FDI positions 35 or 37). All implant failures were reported in subjects that were excluded from the Per Protocol analyses due to exclusion criteria (delayed loading), hence, the Per Protocol cumulative implant survival rate was 100%. For the Per Protocol analysis, 20 implants in 9 subjects have been excluded. Fifteen implants due to protocol violation (late loading), 4 due to implant failure during the healing phase, and 1 due to failure during surgery (a 9 mm-long instead of 6 mm-short implant was inserted). The Per Protocol analysis included 75 implants in 36 subjects.

3.2 | Radiographic bone levels and MBLC

Marginal bone levels are shown in Table 3 and the mean bone level changes (MBLC) from surgery (IP) to loading baseline (T = 0) and from baseline to different follow-up time point until 3 year after loading (T = 36) are shown in Table 4. During the bone remodeling period (ie, after surgery but before loading), there was a slight decrease in mean marginal bone levels of 0.11 ± 0.35 mm. From loading to 6 months and 1, 2, 3 years after loading, the MBLC were kept stable with a tiny change of 0.04 ± 0.36, -0.06 ± 0.55, -0.03 ± 0.53, and 0.07 ± 0.49 mm, respectively. The overall MBLC from IP to 3-years was -0.04 ± 0.32 mm, a figure considered not statistically significant ($P = .3658$). Moreover, only 2 implants experiencing bone loss 1.00–1.30 mm between loading and 3-year follow-up. Bone loss less than 1.00 mm was found in 12.7% implants and bone gain as most as 1.9 mm was found in 22.5% implants. No bone level change was found in 62.0% of the implants (Figure 3). MBLC from baseline showed no significant differences between maxilla and mandible over the 3-year follow-up period (Figure 3).

TABLE 2 Patient characteristics

Patient characteristics		All patients treated (APT)	Per Protocol (PP)
No. of patients and implants		45/95	36/75
Age (years)	Mean	53	54
	Min	26	26
	Max	73	73
Gender	Female	28	22
	Male	17	14
Oral examination	Abnormal jaw relations	1	1
	Periodontitis	36	27
	Bruxism	2	1
Nicotine use	Nonsmokers	40	31
	Habitual smoker	1	1
	Occasional smoker	1	1
	Ex-smoker	3	3
Edentulism prior to treatment (months)	Mean	NA	NA
	Min	4	4
	Max	240	240
Reason for edentulism	Caries/Endodontic	31	27
	Periodontitis	13	8
	Trauma	1	1
Implant location	Maxillary	31	21
	Mandibular	64	54
Implant types	OsseoSpeed TX 4.0S,		
	Length 6 mm	94	75
	Length 9 mm	1	0
Type of restoration	Splinted crowns	95 (94)[a]	75
	Single crowns	1	0

[a]Subject 302 had 2 implants placed, however, one implants was lost due to lack of stability at 5-week post-surgery when taking impression for temporary prosthesis. Subject not included in PP population due to delayed loading.

3.3 | Soft tissue status

Clinical assessment of mean probing depths is shown in Figure 4. The mean probing depths 3 years after loading was 2.71 ± 0.72 mm. From loading to 3-year follow-up, the mean change of PPD in all implants was 0.63 ± 0.83 mm. This increase was not statistically significant. Probing depth increased in 73.6% of the implants (53 of 72). This increase in PPD was within 2 mm in 95.8% of the implants and within 1 mm in 77.8% of the implants (Figure 5).

The proportion of implants with BOP^+ is shown in Figure 6. BOP^+ occurred in 20.3% of implants at loading, in 36.5% of implants at 6 months follow-up, and in 43.2%, 52.7%, and 58.1% of implants at 1-, 2-, and 3-year follow-up respectively. The grand total proportion of implants with plaque was 38.7% during the 3 years follow-up period, and unchanged compared to baseline.

3.4 | Adverse events

Besides 4 implant failures, 2 small ceramic veneer fractures occurred during the follow-up period. No other biological or technical complications were recorded.

TABLE 3 Marginal bone levels at study visits

MBL Average (mm)	Surgery	Loading	Loading + 6 months	Loading + 12 months	Loading + 24 months	Loading + 36 months
N	72[a]	71[a]	72[a]	70[a]	70[a]	72[a]
Mean	0.09	0.20	0.15	0.26	0.21	0.12
Std	0.23	0.46	0.32	0.46	0.38	0.28
Min	0.00	0.00	0.00	0.00	0.00	0.00
Max	1.10	2.05	1.60	2.15	1.45	1.30

[a]Number of radiologically interpretable implants at each visit.

TABLE 4 Marginal bone level changes from implant placement/loading to annual study visits

MBLC Average (mm)	IP to T = 0[a]	T = 0 to T = 6	T = 0 to T = 12	T = 0 to T = 24	T = 0 to T = 36	IP to T = 36
N	71	71	69	69	71	72
Mean	−0.11	0.04	−0.06	−0.03	0.07	−0.04
SD	0.35	0.36	0.55	0.53	0.49	0.32
Min	−1.85	−1.60	−1.75	−1.45	−1.30	−1.30
Max	0.60	1.45	1.60	2.05	1.85	1.00

Comment: Negative values are bone loss and positive values are bone gain.
[a]Visit 5 (loaded with provisional prosthesis) is baseline according to the study protocol (T = 0).

4 | DISCUSSION

This study showed that when placing 2 or 3 implants of 6 mm in length and 4 mm in diameter in the posterior region, restored with a splinted fixed dental prosthesis at 6 weeks post-surgery, predictable clinical and radiographic outcomes after 3 year of loading was accomplished. Few postoperative complications and no relevant side effects were observed, confirming the minimal invasiveness of 6-mm IP.

Meta-analyses present comparable survival rate of rough-surfaced implants shorter than 10 mm with those obtained with longer implants.[2,25,26] However, most surgeons are inclined to use short implants with wider bodies to compensate for the lack of alveolar bone height.[10,27,28] It remains uncertain whether this "compensation" is actually needed or not.[25] Pieri and colleagues reported the treatment outcomes for 6-mm implants with a diameter of 4 mm (OsseoSpeed TX 4.0 S) placed in posterior atrophic mandibles using a two-stage protocol and loaded 5 to 6 months later.[29] Two-year survival and success rates were 96.8% and the mean change in marginal bone levels was 0.51 ± 0.38 mm at the 1-year follow-up. This study also suggests that short implants with a conventional diameter perform well in 3-year loading period. However, it should be noted that the long-term prognosis is yet unknown.

As to the very short implants, as short as 6 mm, at the same time restored with an early loading protocol, only very limited data is available from reliable prospective studies, especially for medium-term or long-term results. In a 1-year multicenter study carried out by Guljé and colleagues, OsseoSpeed 4.0 S implants of 6 mm length were placed in the posterior region and restored with a screw-retained splinted fixed prosthesis after 6 to 7 weeks.[21] The 1-year survival rate was 97%. Mean marginal bone gain around the 6 mm implants was 0.06 ± 0.27 mm after 1 year of function. In a prospective 5-year follow-up cohort study,[13] 40 SLActive 6 mm tissue level implants (diameter 4.8 mm = 21 implants; diameter 4.1 mm = 19 implants) were inserted in 35 patients and restored with single crown after 7 weeks of healing. They reported a survival rate of 95% and a mean marginal bone loss of 0.7 ± 0.6 mm after 5 years of loading. Cannizzaro and colleagues reported that 0.31 mm marginal bone loss was occurred on early-loaded 6.5 mm-long (diameters of 4, 5, or 6 mm, Biomet 3i) single implants after 4 years of loading.[18] The survival rate and success rate was 96.7% and 80%, respectively. Our present study showed similar results, which reported 3-year total survival rate 95.8% and a mean MBLC of 0.07 ± 0.49 mm. However, Rossi and colleagues reported that a lower survival rate of 86.7% was observed at the 6 mm-long, 4.1 mm-diameter implants supporting single crowns loaded within 7 weeks when compared with the same diameter 10 mm-long implants, which was 96.7%.[20]

Most of the studies on the topic of short implants proposed that short implants may be splinted with either short or long implants.[25,30,31] Nevertheless, there is no evidence for such

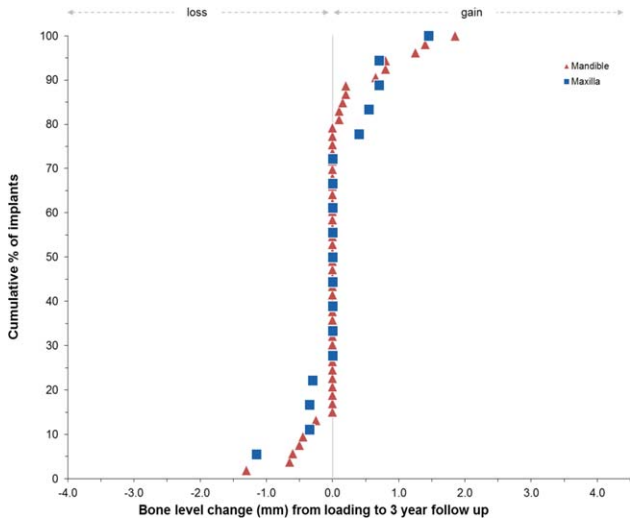

FIGURE 3 MBLC cumulative plot from loading to 3 year after loading

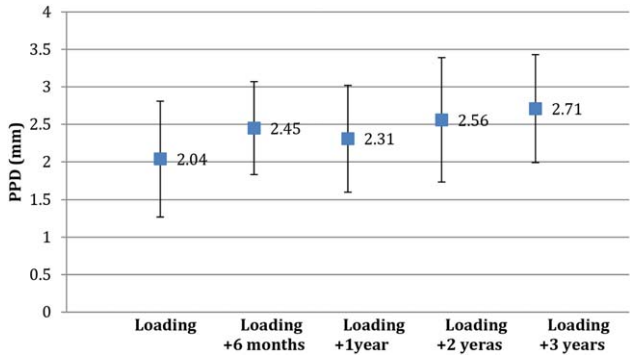

FIGURE 4 Implant probing depth from loading to 3 years after loading

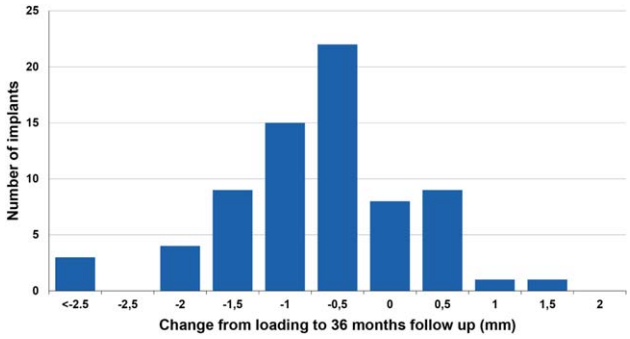

FIGURE 5 Frequency of probing depth change from loading to 3 years after loading

recommendations.[13] Studies evaluating the use of OsseoSpeed short implants (6 mm),[21,29,32] or longer versus short implants[33] have found that the short implant have similar implant survival rates as the longer ones when splinted into a short span bridge. Studies focusing on single crown rehabilitations supported by short OsseoSpeed implants show similar survival rate for the short implants as for longer implants when studied alone[34,35] or compared to longer implants combined with augmentation procedures.[36–38] One study evaluated the clinical outcome of splinted versus nonsplinted prostheses supported by short (6 mm) and longer OsseoSpeed implants.[39] The author's conclusion from this split-mouth study was that marginal bone levels were equally well maintained at short implants as at regular length implants. It is very interesting that the non-splinting of 6 mm-short implants revealed a gain in bone at 24 and 36 months compared with baseline. However, all screw loosening only occurred on the nonsplinted side and implant loss after loading occurred for one 6-mm nonsplinted implant.

The primary aim of this study was to evaluate MBLC after 3-years from loading. The marginal bone was very well maintained and mean change from loading was 0.07 mm (± 0.49 mm). The initial remodeling from IP to loading (after 6 weeks) was in mean −0.11 (0.35 mm) giving a total mean MBLC from IP to 3 years of loading of −0.04 ± 0.32 mm. This bone level change corroborates well with previously published data for the OsseoSpeed implant, short implants[21,22,29,31–34,37,39–41] as well as for standard length implants.[15,16,42–45]

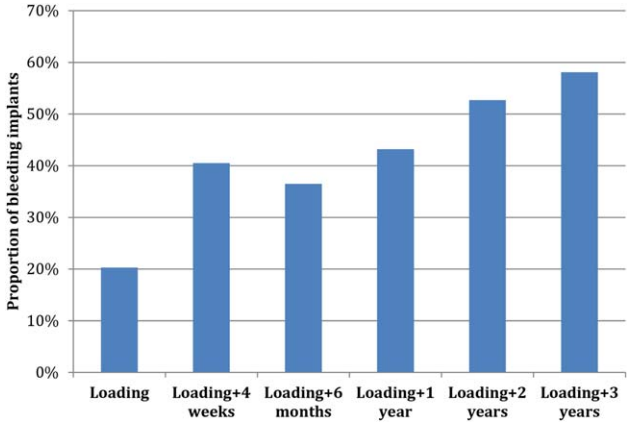

FIGURE 6 Frequency of BOP at implant level

In this study, 4 early implant failures occurred and one implant rotated at 5 weeks post-surgery. The results are in agreement with those from several other studies as reported in a recent review on the outcomes of micro-rough surface Straumann 6 mm implants.[46] The pooled early cumulative survival rates calculated in this meta-analysis was 93.7% and implant failures observed were predominantly early failures. Because all the 4 patients who each lost an implant had a history of severe periodontitis (including one patient who had aggressive periodontitis and bone quality was IV at the surgery site), one was a former heavy smokers, one was a 72 years old male with diabetes mellitus (controlled by pioglitazone hydrochloride), the failure rate may have been determined by a confounding risk factor. It is tempting to speculate that little bone volume caused by severe periodontitis and systemic factors that decrease vascularity or contribute to delayed wound healing, such as those seen in smokers and elderly patients, may have contributed to the failing of osseointegration formation in 6 weeks post-surgery.

In this study, 80.0% of the subjects were diagnosed with periodontitis, in which 28.6% were having severe periodontitis before inclusion in this study. The mean BOP^+ was 91.6% before periodontal treatment. The periodontal condition was much worse than in other studies.[21] All subjects received proper periodontal treatment before implant insertion, including nonsurgical and necessary surgical treatment. After periodontal treatment, the mean BOP^+ decreased to 45.1% and there was no site with probing depth deeper than 5 mm. At the end of 3-year follow-up, the mean probing depth of the observed implants is 2.7 mm, which is not different from what is reported in other studies, and is accompanied by healthy peri-implant soft tissues. This is most probably due to the fact that all these patients received periodontal treatment before implantation and periodontal maintenance was carried out every 6 to 12 months.

4.1 | Clinical implications

The results of this study indicate that 6-mm-short implants provides a treatment option in situations with limited bone height in posterior regions, as short implants may offer greater simplicity and safety compared with bone augmentation procedures. Certainly, long-term follow-up studies are required to confirm this. When using early loading protocol in the 6 mm-short implants, the history of advanced periodontitis, poor bone quality and any systemic factor which can decrease vascularity or contribute to delayed wound healing should be taken into consideration. In these cases, conventional loading protocol is much safer. Considering the limited portion of the implants engaged in bone, high prevalence of periodontitis in the Chinese population and relatively poor oral hygiene compared to western people, a regular maintenance program is mandatory for the Chinese patient to reduce the risk of excessive marginal bone resorption, including peri-implantitis, in the long term.

5 | CONCLUSION

Three-year data indicate that treatment with 6 mm-short implants is reliable when used to support splinted crowns in the posterior maxilla

or mandible. Proper and necessary periodontal treatment before implant installation is mandatory for patients with periodontitis and strictly follow-up maintenance is a requisite for long-term success.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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How to cite this article: Han J, Tang Z, Zhang X, Meng H. A prospective, multi-center study assessing early loading with short implants in posterior regions. A 3-year post-loading follow-up study. *Clin Implant Dent Relat Res*. 2018;20:34–42. https://doi.org/10.1111/cid.12568