

# Comparison of clinical and radiographic status around immediately loaded versus conventional loaded implants placed in patients with type 2 diabetes: 12- and 24-month follow-up results

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**SUMMARY** There are no studies that have compared the clinical and radiographic status around immediately loaded (IL) and conventional loaded (CL) implants placed in patients with type 2 diabetes mellitus (T2DM). The aim was to compare the clinical and radiographic status around IL and CL implants placed in T2DM patients. One hundred and eight diabetic patients [55 with IL implants (Group 1) and 53 with CL implants (Group 2)] were included in this cross-sectional study. All implants were placed in healed sites in the maxillary and mandibular premolar and molar regions and supported single restorations. All patients underwent full mouth mechanical debridement biannually. Haemoglobin A1c (HbA1c) levels, clinical [bleeding on probing (BOP) and probing depth (PD)  $\geq 4$  mm] and radiographic [crestal bone loss (CBL)] peri-implant parameters were measured for both groups at 12- and 24-month follow-up. Group comparisons were performed using the

Mann–Whitney *U*-test ( $P < 0.05$ ). The mean age and duration of T2DM in groups 1 and 2 were  $50.6 \pm 2.2$  and  $51.8 \pm 1.7$  years, and  $9.2 \pm 2.4$  and  $8.5 \pm 0.4$  years, respectively. At 12- and 24-month follow-up, the mean HbA1c levels in groups 1 and 2 were 5.4% (4.8–5.5%) and 5.1% (4.7–5.4%) and 5.1% (4.7–5.2%) and 4.9% (4.5–5.2%), respectively. At 12- and 24-month follow-up, there was no statistically significant difference in peri-implant BOP, PD and CBL in both groups. It was concluded that clinical and radiographic status is comparable around IL and CL implants placed in patients with T2DM. The contribution of careful case selection, oral hygiene maintenance and glycaemic control is emphasised.

**KEYWORDS:** dental implant, peri-implant parameters, crestal bone loss, immediate loading, conventional loading, type 2 diabetes mellitus

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## Background

The high predictability of dental implants in the rehabilitation of oral aesthetics and function is well documented. With advancements in clinical implant dentistry, clinicians have progressively commenced to evaluate the possibilities of decreasing treatment time by early placement of the implant-supported

restoration. According to Corradini *et al.* (1), immediate loading of implants is a reliable treatment approach for oral rehabilitation. Romanos and Nentwig (2) evaluated the clinical success of immediately loaded (IL) implants versus delayed-loaded (DL) implants placed in the posterior mandible of healthy individuals. After a mean follow-up of approximately 24 months, the mean scores of plaque index, gingival

index and probing depth (PD) were comparable among IL and DL implants. The authors concluded that immediately and delayed-loaded implants in healthy individuals had the same prognosis after 24 months (2). A number of randomised controlled trials (RCTs) on healthy subjects have assessed implant failure rates under immediate loading compared with delayed loading (3–8). These studies have reported no statistically significant difference in implant failure rate between IL versus DL implants (2.87% versus 1.8%, respectively) (3–7). However, contradictory results have also been reported. In a retrospective cohort study, Susarla *et al.* (9) assessed the 12-month survival for DL versus IL implants. The study sample comprised of 677 individuals who had 2349 DL dental implants and 178 patients who had 477 IL implants. The results showed that IL implants were 2.7 times more likely to fail at 1 year compared with DL implants (9). However, this conclusion was in disregard of the systemic health of the participants.

Chronic hyperglycaemia [such as among patients with type 2 diabetes mellitus (T2DM)] is a significant risk factor for peri-implant soft tissue inflammation (10–12). Moreover, crestal bone loss (CBL) around dental implants placed in patients with T2DM has also been shown to be significantly higher compared with non-diabetic individuals (11). However, although there is a higher risk of failure in diabetic patients, experimental studies have shown that the optimisation of glycaemic control improves the degree of implants osseointegration (13).

Currently, there are no studies that have compared the clinical [peri-implant bleeding on probing (BOP) and  $PD \geq 4$  mm] and radiographic [crestal bone loss (CBL)] status around IL and conventional loaded (CL) implants placed in patients with T2DM. In this study, it was hypothesised that under optimal glycaemic control and oral hygiene measures, peri-implant BOP,  $PD \geq 4$  mm and CBL are comparable among IL and CL implants placed in patients with T2DM. Therefore, the aim of this study was to compare the clinical and radiographic status around IL and CL implants placed in patients with T2DM at 12- and 24-month follow-up.

## Methods

### *Study design and participants*

A retrospective chart review of patients who were eligible for single implant restoration in the maxillary and

mandibular premolar and molar regions was developed for data extraction. The inclusion criteria were as follows: (i) patients with T2DM, (ii) patients with IL or CL implants and (iii) signing of consent form. Tobacco smokers and chewers, individuals with self-reported diseases other than T2DM (such as type 1 DM and AIDS), patients undergoing cancer therapy, patients having undergone bone augmentation (guided bone regeneration), pregnant and/or lactating females, patients with history of bruxism and/or periodontal disease and patients who reported to have used antibiotics, non-steroidal anti-inflammatory drugs and/or corticosteroids within the past 3 months were excluded.

### *Surgical protocol and implant-related characteristics*

All implants were placed under local anaesthesia using surgical guides. Full-thickness mucoperiosteal flaps were raised, and bone-level platform-switched implants\* with diameters and lengths ranging between 3.3 mm and 4.1 mm and 10 mm to 14 mm, respectively, were placed. In groups 1 and 2, implants were placed using insertion torques ranging between 30 and 35 Ncm. Each patient was prescribed amoxicillin (2 g orally one hour before surgery, followed by two additional 500-mg doses that day and then 500 mg 3 times a day for 5 days). Patients with amoxicillin sensitivity were prescribed clindamycin (600 mg 1 h before surgery, followed by 150 mg four times a day for 5 days). Pain was controlled by analgesics (600 mg ibuprofen one every 8 h for as long as required). Oral hygiene instructions were given, and the patients were also recommended to rinse with an essential oil-based mouthwash (Listerine Zero<sup>†</sup>) twice daily for 2 weeks, 24 h after surgery. Until 2 years of follow-up, individuals in groups 1 and 2 had been enrolled in a biannual dental prophylaxis programme in which they received mechanical plaque and calculus removal from all teeth and/or implant surfaces using an ultrasonic scaler<sup>‡</sup>.

### *Immediate loading protocol*

The immediate loading was performed two days after implant placement (Group 1) with screw-retained

\*Straumann AG, Basel, Switzerland.

<sup>†</sup>Johnson & Johnson Middle East FZ – LLC, Dubai, UAE.

<sup>‡</sup>VV DENTA, Guangxi, China.

non-occluding provisional crowns that were replaced with the permanent crowns six weeks later. Temporary abutments (RC Temporary Abutment; Straumann AG) were attached to the implants using a torque controller (manual torque wrench; Straumann AG) with a force of 25 Ncm to hold the acrylic crowns. The prefabricated temporary crowns designed with narrow occlusal table were relined with a bis-acrylic composite (Protemp II)<sup>§</sup>. The interproximal contacts were designed as broader contact areas to distribute the forces of mastication and provide support. As a precautionary measure, patients were instructed to avoid hard diet and to wear a nightguard during the first 6 weeks for mandibular implants and 8 weeks for maxillary implants (2). One week after surgery, the patients were recalled to check complications and to reassess occlusion.

#### *Conventional loading protocol and prosthesis-related characteristics*

The conventional loading was performed  $3.1 \pm 0.2$  months after implant placement in Group 2. Master models (GC Fujirock EP die stone)<sup>¶</sup> were obtained from fixture-level impression using transfer impression copings and polyvinyl siloxane (PVS) material (Virtual)\*\* with the open-tray technique. Jaw relationships were recorded by means of a wax or silicon medium in maximum intercuspation. The stone casts were mounted in a semi-adjustable articulator. For standardisation purposes, all implants were restored with screw-retained metal ceramic (MC) crowns with full ceramic coverage to preclude the detrimental effect of extruded excess cement. Customised metal abutments (synOcta cast gold abutment; Straumann AG) were cast on using a precious gold–palladium (Au 49.60%, Pd 29.00%, Ag 17.5%) alloy (Degubond 4)<sup>††</sup>. All MC crowns were fabricated by the same dental laboratory following the standard procedures. Then, crowns were torqued (35 Ncm) according to the manufacturer's recommendation before the abutment screw access channel was filled with polytetrafluoroethylene (PTFE) seal tape (Kanca

Makine, Istanbul, Turkey) and light-cured composite resin (Filtek P60)<sup>‡‡</sup>. The crown occlusion was designed to harmonise with patient's existing physiologic occlusion. Additionally, light centric contacts on the implants were obtained in maximum intercuspation to minimise occlusal forces on the implant and to maximise force distribution to the adjacent natural teeth. Moreover, complete disocclusion was ensured during eccentric movements. Oral hygiene instructions and the follow-up protocol were discussed. All patients in both groups were enrolled in a biannual recall programme.

#### *Clinical and radiographic evaluations*

Radiographs were taken at the time of implant placement, after loading and at 12- and 24-month follow-up. All clinical and radiographic assessments were performed by a single trained and calibrated clinician who was blinded to the study groups ( $kappa$  was 0.91). In both groups, peri-implant BOP and PD  $\geq 4$  mm were measured at six sites per implant (mesiobuccal, mid-buccal, distobuccal, mesiolingual, mid-lingual and distolingual) using a plastic periodontal probe (Plast-o-Probe, Dentsply Maillefer). Peri-implant suppuration was also noted. Digital intraoral radiographs<sup>§§</sup> were taken and viewed on a computer screen at 20 $\times$  magnification using computer software (CorelDraw 11.0)<sup>¶¶</sup>. The radiographic paralleling technique was standardised using a film holder as a guiding device for X-ray beams<sup>\*\*\*</sup>. In each group, the mean mesial CBL and distal CBL were recorded in millimetres on digital radiographs using a software program (Scion Image)<sup>†††</sup>. The software was calibrated before each measurement using the predefined implant length. Mesial CBL and distal CBL were measured on all implants in both groups as the distance from the widest supracrestal part of the implant to the alveolar crest. Together with the clinical and radiographic evaluations, HbA1c levels were measured for all participants at 12- and 24-month follow-up

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<sup>††</sup>DeguDent GmbH, Hanau-Wolfgang, Germany

<sup>‡‡</sup>3M, St. Paul, MN, USA

<sup>§§</sup>Belmont ACURAY 071A Intra Oral X-Ray System, Hudson, FL, USA

<sup>¶¶</sup>Corel Corporation, Ottawa, ON, Canada

<sup>\*\*\*</sup>Dentsply Rinn, York, PA, USA.

<sup>†††</sup>Scion Corp., Fredrick, MD, USA

using an HbA1c analyser kit (Quo-Test)<sup>\*\*\*</sup>. An implant was considered successful if it is satisfactorily functioning with no mobility, sign of radiolucency and/or fracture at the time for loading or at follow-up.

#### *Survival/Success criteria*

Survival was defined as the presence of the implant and its suprastructure *in situ* in its original extension at follow-up examination with or without complications. Success was defined as the presence of the implant and its suprastructure *in situ* without any mechanical or technical complications during the entire follow-up period. Success criteria were lack of mobility, the absence of peri-implant radiolucency, recurrent peri-implant infection or suppuration, continuous or recurrent pain or tenderness, or structural failure of the implant and/or restoration, and/or > 0.2 mm bone resorption annually after the implant's first year of service (14).

#### *Statistical analysis*

Statistical analysis was performed using software program (SPSS Version 18)<sup>§§§</sup>. In groups 1 and 2, BOP, PD  $\geq$  4 mm and CBL were assessed using the Mann-Whitney *U*-test at 12- and 24-month follow-up. *P*-values <0.05 were considered statistically significant.

## Results

#### *General characteristics of the study population*

A total of 115 male type 2 diabetics (57 with IL and 58 with CL implants) were invited to participate in this investigation. One hundred and eight individuals (Group 1: 55 IL implants and Group 2: 53 CL implants) volunteered to participate. All included implants were with moderately rough surface and platform switching design that were placed in healed sockets at the level of bone crest. There were no drop-outs reported during the 24-month follow-up period. The mean age of patients in groups 1 and 2 was  $50.6 \pm 2.2$  and  $51.8 \pm 1.7$  years, respectively. In

groups 1 and 2, the mean duration of T2DM was  $9.2 \pm 2.4$  and  $8.5 \pm 0.4$  years, respectively. At 12- and 24-month follow-up, the mean HbA1c levels among patients in groups 1 and 2 were 5.4% (4.8–5.5%) and 5.1% (4.7–5.4%) and 5.1% (4.7–5.2%) and 4.9% (4.5–5.2%), respectively (Table 1). All patients were taking oral hypoglycaemic medications and following dietary control regimens for the management of T2DM. All patients were enrolled in a biannual oral hygiene maintenance programme.

#### *Clinical and radiographic parameters*

The mean scores of BOP and PD  $\geq$  4 mm in both groups are presented in Table 1. At 12 and 24 months of follow-up, there was no statistically significant difference in peri-implant BOP and PD  $\geq$  4 mm between the two groups.

At the 12-month follow-up, the total CBL in groups 1 and 2 was 0.55 and 0.56 mm, respectively. At the 24-month follow-up, the total CBL in groups 1 and 2 was 0.58 and 0.64 mm, respectively. At 12- and 24-month follow-up, there was no statistically significant difference in the mean mesial, distal and total CBL around implants in both groups (Figs 1 and 2). The overall implant and crown survival and success rates were 100% in both groups without any serious biologic or mechanical complications (Fig. 3).

## Discussion

The aim of the present study was based on the hypothesis that under optimal glycaemic control and oral hygiene measures, peri-implant BOP, PD  $\geq$  4 mm and CBL are comparable among IL and CL implants placed in patients with T2DM. This hypothesis was confirmed according to the results of the present study. These findings are in line with those reported by Aguilar-Salvatierra *et al.* (10), which showed that IL implants can safely be placed in diabetic patients provided that blood glycaemic levels are under control; however, their study lacks a control group where only immediately loaded implants were placed merely in the anterior maxilla. Although the present study failed to find differences in clinical and radiographic parameters between IL and CL implants in type-2 diabetic patients over the 2-year follow-up, emphasis should be placed on appropriate case selection (10).

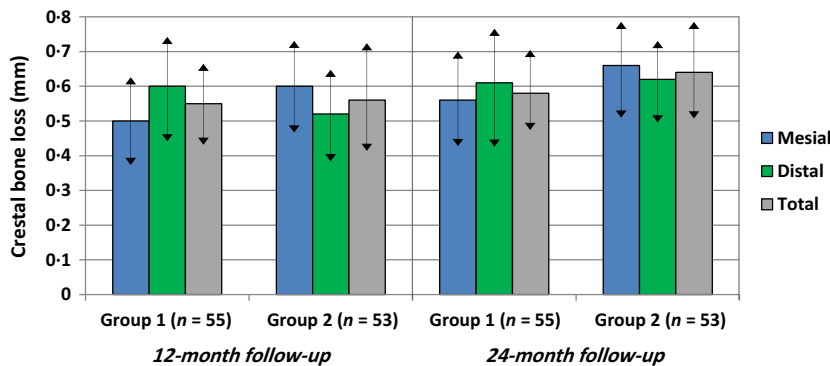
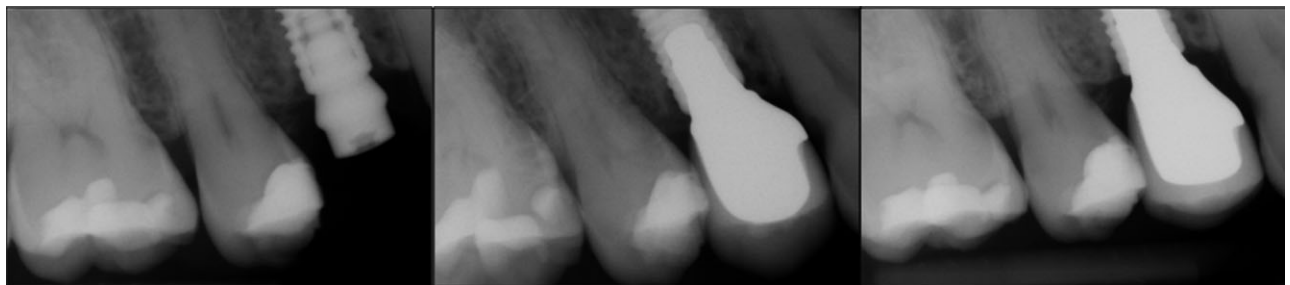
<sup>\*\*\*</sup>EKF Diagnostics, Magdeburg, Germany

<sup>§§§</sup>SPSS Inc., Chicago, IL, USA.

**Table 1.** HbA1c levels and clinical parameters around immediately loaded (Group 1) and conventional loaded (Group 2) dental implants at 12 and 24 months of follow-up

	Parameters	Group 1 ( <i>n</i> = 55)		Group 2 ( <i>n</i> = 53)	
		Maxilla	Mandible	Maxilla	Mandible
12-month follow-up	HbA1c (%)	5.4 (4.8–5.5)		5.1 (4.7–5.4)	
	BOP (%)	12.5 ± 2.5	16.6 ± 3.7	13.4 ± 0.3	16.5 ± 2.2
	PD ≥ 4 mm (%)	3 ± 0.1	3.6 ± 0.2	3.3 ± 0.1	4.1 ± 0.2
24-month follow-up	HbA1c (%)	5.1 (4.7–5.2)		4.9 (4.5–5.2)	
	BOP (%)	10.5 ± 0.5	10.1 ± 0.2	10.2 ± 0.3	9.1 ± 0.2
	PD ≥ 4 mm (%)	2 ± 0.1	2.4 ± 0.2	1.8 ± 0.1	2.1 ± 0.2

BOP, bleeding on probing; PD, probing depth

**Fig. 1.** Crestal bone loss (CBL) in groups 1 and 2 at 12- and 24-month follow-up. Blue bars represent the mesial CBL; green bars represent the distal CBL; and grey bars represent the total CBL. [Colour figure can be viewed at [wileyonlinelibrary.com](#)]**Fig. 2.** Digital radiographs of implant and crown at different follow-up timepoints; baseline (left), 12 months (middle) and 24 months (right).

In general, there are many interacting factors that would affect the success of immediately loaded implants such as bone quality and quantity, clinician skill and experience, implant design, implant primary stability, macro- and micromovements and occlusion (15). In the present study, a variety of local and systemic factors may have influenced the presented results. All implants used in the present study were

platform-switched (PS). Implants placed according to the PS concept have been reported to undergo significantly less CBL and peri-implant soft tissue inflammation as compared to implants with matching abutment and implant-body diameters (non-PS implants) (16, 17). It may also be proposed that the implant insertion torque used in the present investigation (30–35 Ncm) may also have contributed



**Fig. 3.** Clinical photographs of implant restoration: 12-month buccal view (top), 24-month buccal view (bottom), 24-month occlusal view (right) [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)].

towards the primary stability of the peri-implant crestal bone levels. Studies (18, 19) have reported that implant insertion torque values of  $<50$  Ncm do not jeopardise the peri-implant crestal bone levels. It is therefore probable that in the present study, use of PS implants and implant insertion torques of  $<50$  Ncm may have contributed towards the stability of peri-implant crestal bone. However, contradictory results have also been reported (20). In the study by Bidgoli *et al.* (20), insertion torque values of up to 70 Ncm did not significantly increase CBL around implants. Moreover, occlusal forces were minimised by narrowing the bucco-lingual width of the occlusal table and by maintaining minimum centric contacts and complete disocclusion in eccentric movements.

It is imperative to note that these patients reported in the current investigation had screw-retained implant-supported single restorations, which may perform differently from multiunit or cement-retained prostheses (21). Both favourable (3–5) and unfavourable (6, 9) clinical outcomes have been reported in healthy individuals with immediately loaded multiunit prostheses or implant-retained overdentures. In addition, dental implants have demonstrated different performance in association with location in the arch due to variations in the quality and quantity of bone, history of trauma to the region, proximity of important structures, need for bone grafting and other supplemental surgical procedures, degree of arterial blood

supply and rate of tissue healing (22). In a recent study by Ozgur *et al.* (23), it was shown that CBL is higher around implants placed in the posterior maxillary region compared to the mandible. Although implants included in the present investigation were placed in the posterior maxilla or mandible, no significant differences in tested parameters were demonstrated in both groups. This finding supports a radiographic study by Nandal *et al.* (24), which showed that CBL was comparable in both maxilla and mandible on both mesial and distal aspects of implants.

Chronic hyperglycaemia is a significant risk factor for oral soft tissue inflammation and bone loss around implants (10). Because of the microvascular complications deriving from hyperglycaemia, vascularisation of the tissue is compromised, healing is delayed, and wounds are more predisposed to infection (13). However, under optimal glycaemic control, dental implants can osseointegrate and remain functionally stable for prolonged durations in patients with diabetes mellitus. It is notable that in the present study, patients in groups 1 and 2 had well-controlled T2DM at 12- and 24-month follow-up. All patients included in the present study reported to have been maintaining their glycaemic levels via hypoglycaemic medications and dietary control. This may have contributed towards a reduced inflammatory stress in the peri-implant tissues, which in turn may have contributed

to the stability of crestal bone around IL and CL implants.

In the present study, all participants were undergoing biannual mechanical plaque and calculus debridement. Non-surgical periodontal therapy (NSPT) has been reported to play a significant role in minimising oral soft tissue inflammation and reducing serum glycaemic levels among diabetic patients (25). It is therefore likely that oral hygiene maintenance would have contributed towards maintaining a healthy peri-implant soft tissue and minimising CBL. Moreover, the biannual NSPT may also have contributed (in addition to the use of antihyperglycaemic medications and dietary control) towards the prevention of the development of a chronic hyperglycaemic state in the investigated patient population. Both the oral hygiene maintenance and glycaemic control may have contributed to 100% success and survival rates of the implants in both groups. This conclusion was previously reported by Degidi *et al.* (26) who stated that as long as the oral hygiene status is satisfactory, dental implants can exhibit a 100% survival rate.

The criteria to define success in implant dentistry are under constant debate. The loss of 2 mm of bone around the implant neck during the first year after functional loading followed by not more than 0.2 mm per year has long been assumed a successful outcome (14). Due to advancements in surgical techniques, implant design and surface topographic modifications, peri-implant CBL has been progressively decreasing (27). Therefore, recent studies have questioned the widely accepted success criteria of up to 2 mm CBL at 1 year followed by a maximum of 0.2 mm annually (14,28). It appears that the consideration of CBL rates rather than raw CBL data may improve the ability of clinicians to predict peri-implant disease. Galindo-Moreno *et al.* (14) showed that bone loss rates at 18 months were strongly associated with the initial bone loss rate. If the CBL is higher than the cut-off value of 0.44 mm at 6 months post-loading, CBL progression tends to be significantly higher, with an increased risk of implant failure (14). Although 6-month measurements of CBL were not sought in the present investigation, the present results were in line with this recommendation and other recently published data of microroughened implants (14,27,29,30). New success criteria that correspond to the currently accepted values of CBL around microroughened surface implants should be developed based on CBL rates

during time intervals rather than on the peri-implant CBL value after a given period of time (14).

Potential limitations of the present study are that all included patients were non-smokers with well-controlled T2DM which does not reflect the clinical reality. It is expected that peri-implant soft tissue inflammation is worse and CBL is significantly higher around IL and CL implants placed in smokers with poorly controlled T2DM. Another limitation would be the well-controlled glycaemic level of included diabetic patients, a state that is rarely found in real practice. This condition may be as a result of the high socio-economic status of included patients as the clinics are located in the high-class commercial district. In addition, the medical service and medications are offered free to the public by the government. Furthermore, all participants in the present study were males, which may have been a source of bias. There is a possibility that hormonal changes in females (particularly in the postmenopausal phase) may influence the oral soft and hard tissue status around IL and CL implants as compared to males. Finally, radiographic assessment of CBL was limited to mesial and distal bone as measurements were based on 2-dimensional radiographs. Therefore, other areas such as labial/buccal and palatal/lingual surfaces that might have exhibited CBL to an extent could not be assessed. Further studies using cone beam computed tomography (CBCT) may help assess CBL around IL and CL implants in different planes. Different findings could have been demonstrated clinically and radiographically if the follow-up was for a longer duration. However, this time frame is sufficient to understand the role of immediate loading, in comparison with conventional or delayed loading, on the early clinical performance of dental implants in type 2 diabetic patients. Further long-term randomised controlled clinical trials are needed to confirm these hypotheses.

## Conclusion

Within the limitations of this study, it can be concluded that the clinical and radiographic status was comparable around IL and CL implants placed in patients with T2DM up to 24 months of follow-up. During the follow-up period, both IL and CL implants had similarly acceptable clinical and radiographic outcomes with regard to soft tissue condition, crestal bone level, and implant and prosthetic success rate in

patients with T2DM. Although it seems that differences in implant outcomes do not merely depend on the time of loading, the contribution of careful case selection, oral hygiene maintenance and glycaemic control cannot be overlooked.

### Conflict of interest and financial disclosure

The authors have stated explicitly that there are no conflict of interests in connection with this article and that there was no external source of funding for the present study.

### Ethical approval

The research protocol was reviewed and approved by the Research Ethics Review Committee of the College of Applied Medical Sciences, King Saud University, Riyadh, Saudi Arabia. All participants were requested to sign a consent form. All participants reserved the right to retire from the present study at any stage of the investigation.

### References

1. Corradini G, Delle Donne U, Boni W, Tettamanti L, Tagliabue A. Immediate versus delayed loading implants: rationale and controversies. *J Biol Regul Homeost Agents*. 2015;29:14–18.
2. Romanos GE, Nentwig GH. Immediate versus delayed functional loading of implants in the posterior mandible: a 2-year prospective clinical study of 12 consecutive cases. *Int J Periodontics Restorative Dent*. 2006;26:459–469.
3. Chiapasco M, Abati S, Romeo E, Vogel G. Implant-retained mandibular overdentures with Branemark System MKII implants: a prospective comparative study between delayed and immediate loading. *Int J Oral Maxillofac Implants*. 2001;16:537–546.
4. Romeo E, Chiapasco M, Lazza A, Casentini P, Ghisolfi M, Iorio M *et al*. Implant-retained mandibular overdentures with ITI implants. *Clin Oral Implants Res*. 2002;13:495–501.
5. Jokstad A, Alkumru H. Immediate function on the day of surgery compared with a delayed implant loading process in the mandible: a randomized clinical trial over 5 years. *Clin Oral Implants Res*. 2014;25:1325–1335.
6. De Smet E, Duyck J, Vander Sloten J, Jacobs R, Naert I. Timing of loading—immediate, early, or delayed—in the outcome of implants in the edentulous mandible: a prospective clinical trial. *Int J Oral Maxillofac Implants*. 2007;22:580–594.
7. Barewal RM, Stanford C, Weesner TC. A randomized controlled clinical trial comparing the effects of three loading protocols on dental implant stability. *Int J Oral Maxillofac Implants*. 2012;27:945–956.
8. Romanos GE, Aydin E, Locher K, Nentwig GH. Immediate vs. delayed loading in the posterior mandible: a split-mouth study with up to 15 years of follow-up. *Clin Oral Implants Res*. 2016;27:E74–E79.
9. Susarla SM, Chuang SK, Dodson TB. Delayed versus immediate loading of implants: survival analysis and risk factors for dental implant failure. *J Oral Maxillofac Surg*. 2008;66:251–255.
10. Aguilar-Salvatierra A, Calvo-Guirado JL, Gonzalez-Jaranay M, Moreu G, Delgado-Ruiz RA, Gomez-Moreno G. Peri-implant evaluation of immediately loaded implants placed in esthetic zone in patients with diabetes mellitus type 2: a two-year study. *Clin Oral Implants Res*. 2016;27:156–161.
11. Gomez-Moreno G, Aguilar-Salvatierra A, Rubio Roldan J, Guardia J, Gargallo J, Calvo-Guirado JL. Peri-implant evaluation in type 2 diabetes mellitus patients: a 3-year study. *Clin Oral Implants Res*. 2015;26:1031–1035.
12. Al Amri MD, Kellesarian SV, Al-Kheraif AA, Malmstrom H, Javed F, Romanos GE. Effect of oral hygiene maintenance on HbA1c levels and peri-implant parameters around immediately-loaded dental implants placed in type-2 diabetic patients: 2 years follow-up. *Clin Oral Implants Res*. 2016;27:1439–1443. doi:10.1111/clr.12758.
13. Mellado-Valero A, Ferrer Garcia JC, Herrera Ballester A, Labaig Rueda C. Effects of diabetes on the osseointegration of dental implants. *Med Oral Patol Oral Cir Bucal*. 2007;12: E38–E43.
14. Galindo-Moreno P, León-Cano A, Ortega-Oller I, Monje A, O'Valle F, Catena A. Marginal bone loss as success criterion in implant dentistry: beyond 2 mm. *Clin Oral Implants Res*. 2015;26:E28–E34.
15. Esposito M, Grusovin MG, Maghahah H, Worthington HV. Interventions for replacing missing teeth: different times for loading dental implants. *Cochrane Database Syst Rev*. 2013; (3):CD003878.
16. Vandeweghe S, De Bruyn H. A within-implant comparison to evaluate the concept of platform switching: a randomised controlled trial. *Eur J Oral Implantol*. 2012;5:253–262.
17. Atieh MA, Ibrahim HM, Atieh AH. Platform switching for marginal bone preservation around dental implants: a systematic review and meta-analysis. *J Periodontol*. 2010;81:1350–1366.
18. Barone A, Alfonsi F, Derchi G, Tonelli P, Toti P, Marchionni S *et al*. The effect of insertion torque on the clinical outcome of single implants: a randomized clinical trial. *Clin Implant Dent Relat Res*. 2016;18:588–600.
19. Calvo-Guirado JL, Lopez Torres JA, Dard M, Javed F, Perez-Albacete Martinez C, Mate Sanchez de Val JE. Evaluation of extrashort 4-mm implants in mandibular edentulous patients with reduced bone height in comparison with standard implants: a 12-month results. *Clin Oral Implants Res*. 2016;27:867–874.
20. Bidgoli M, Soheilifar S, Faradmal J. High insertion torque and peri-implant bone loss: Is there a relationship? *J Long Term Eff Med Implants*. 2015;25:209–213.



21. Shapoff CA, Lahey BJ. Crestal bone loss and the consequences of retained excess cement around dental implants. *Compend Contin Educ Dent.* 2012;33:94–96, 98–101; quiz 102, 112.
22. Tolstunov L. Implant zones of the jaws: implant location and related success rate. *J Oral Implantol.* 2007;33:211–220.
23. Ozgur GO, Kazancioglu HO, Demirtas N, Deger S, Ak G. Risk factors associated with implant marginal bone loss: a retrospective 6-year follow-up study. *Implant Dent.* 2016;25:122–127.
24. Nandal S, Ghalaut P, Shekhawat H. A radiological evaluation of marginal bone around dental implants: an in-vivo study. *Natl J Maxillofac Surg.* 2014;5:126–137.
25. Corbella S, Francetti L, Taschieri S, De Siena F, Fabbro MD. Effect of periodontal treatment on glycemic control of patients with diabetes: a systematic review and meta-analysis. *J Diabetes Investig.* 2013;4:502–509.
26. Degidi M, Nardi D, Piattelli A. 10-year follow-up of immediately loaded implants with TiUnite porous anodized surface. *Clin Implant Dent Relat Res.* 2012;14:828–838.
27. Koodaryan R, Hafezeqoran A. Evaluation of implant collar surfaces for marginal bone loss: a systematic review and meta-analysis. *Biomed Res Int.* 2016;2016:4987526.
28. Ibañez C, Catena A, Galindo-Moreno P, Noguerol B, Magán-Fernández A, Mesa F. Relationship between long-term marginal bone loss and bone quality, implant width, and surface. *Int J Oral Maxillofac Implants.* 2016;31:398–405.
29. de Araújo Nobre M, Maló P, Gonçalves Y, Sabas A, Salvado F. Dental implants in diabetic patients: retrospective cohort study reporting on implant survival and risk indicators for excessive marginal bone loss at 5 years. *J Oral Rehabil.* 2016;43:863–870.
30. Hsu YT, Chan HL, Rudek I, Bashutski J, Oh WS, Wang HL *et al.* Comparison of clinical and radiographic outcomes of platform-switched implants with a rough collar and platform-matched implants with a smooth collar: a 1-year randomized clinical trial. *Int J Oral Maxillofac Implants.* 2016;31:382–390.

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