A Prospective Randomized Clinical Trial on Radiographic Crestal Bone Loss Around Dental Implants Placed Using Two Different Drilling Protocols: 12-Month Follow-up

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Purpose: There is a substantial need to perform studies to evaluate crestal bone loss (CBL) and implant success when using a newly introduced low-speed drilling protocol. Therefore, this study aimed to evaluate the mean CBL and implant success rate by placing implants utilizing two drilling protocols, ie, standard and low-speed drilling protocols. Materials and Methods: A randomized controlled clinical trial was carried out in patients who required dental implants to restore their esthetics and function. The patients were recruited from a university hospital (Academic Centre for Dentistry Amsterdam [ACTA], the Netherlands). Based on the inclusion criteria, patients were randomized to two study groups: (1) control group, standard drilling protocol; and (2) test group, low-speed drilling protocol without saline irrigation. The mean CBL and the implant success rate were evaluated after 12 months of implant placement. Results: Twenty-three patients (15 men and 8 women with a mean age of 57.5 ± 10.7 years) contributed to the study. Forty Camlog screw-line implants were placed (20 implants per study group). After 12 months of implant placement, the mean CBL of implants placed with the standard protocol and the low-speed protocol was 0.206 ± 0.251 mm and 0.196 ± 0.178 mm, respectively. No statistically significant difference could be recorded among both groups (P = .885). Concerning implants placed in the maxilla, the standard drilling group and low-speed drilling group showed a mean CBL of 0.252 ± 0.175 mm and 0.251 ± 0.175 mm, respectively, compared with 0.173 ± 0.210 mm and 0.141 ± 0.177 mm in the mandible, with no significant difference. The success rate of dental implants at 12 months was 95% in the control group and 90% in the test group. Conclusion: Within the limitations of this study, it can be concluded that implants placed with the low-speed drilling protocol without saline irrigation exhibited a similar CBL compared with implants placed with the standard drilling protocol. However, a higher success rate was recorded especially in type 1–quality bone for the control group compared with the test group. Further randomized clinical trials with greater sample sizes and extended follow-up times should be performed to obtain stronger evidence and a better understanding of the influence of drilling speed on mean CBL and long-term implant success. Int J Oral Maxillofac Implants 2021;36:e175–e182. doi: 10.11607/jomi.9029

Keywords: crestal bone loss, dental implant, low-speed drilling, standard drilling

Currently, titanium implants are considered a first treatment option for the replacement of missing teeth, mainly due to the high success rates, among other reasons.1–3 The factors that can significantly affect osseous integration of titanium implants can be classified into four major categories: (1) surgical technique for implant placement, (2) implant design and surface characteristics, (3) host bone, and (4) loading protocol.4–6 One of the main reasons for the biologic failures of dental implants is surgical trauma.7, 8 The key to successful implant placement is careful surgical planning and execution.8 The bone regeneration demands minimal surgical trauma or injury to the bone, especially in terms of thermal trauma.9 Thermal injury may cause the formation of necrotic bone and consequent connective formation between a dental implant and bone, resulting in the failure
of the implant. The parameters that significantly influence heat production during osteotomy preparation include drilling speed, saline irrigation, type of drilling (continuous or intermittent), the sharpness of the drill, pressure applied during drilling, host bone density, and the discrepancy between the osteotomy diameter and implant diameter.

The implant site preparation is carried out mainly with bone-cutting drills at a high speed with irrigation to avoid frictional heat generation, which can adversely affect bone healing. Surgical techniques currently in use for implant site preparation employ drilling speeds of 800 to 1,200 rpm with subsequent cooling with sterile saline. Cooling of an implantation site with saline irrigation has been supported to minimize bone overheating. On the other hand, saline irrigation can interfere with the clinician’s vision and prevent the collection of bone chips from the drill threads.

However, it has been confirmed by many authors that implant site preparation can be completed without saline irrigation if a low-speed drilling protocol is employed. It has been reported that low-speed drilling without aqueous irrigation does not generate temperatures above 47°C due to minimal frictional heat production. Augustin et al reported that at 188-rpm and 462-rpm drilling speeds, the temperature range without external irrigation was 31.4°C to 36.9°C and 35.2°C to 43.0°C, respectively. Given this, one can assume that it is safe to employ a modified drilling protocol (speed < 200 rpm) using uninterrupted drilling time < 60 seconds without aqueous irrigation for implant site preparation. However, only one clinical study has been conducted so far to analyze and compare the mean crestal bone loss (CBL) between standard and low-speed drilling protocols.

The CBL after placement and loading of titanium implants is considered a principal and reliable parameter for appraising peri-implant health status and long-term clinical success. After 3 weeks of implant placement, osteoblast attachment and adhesion on the surface of the implant and start of new bone formation has been observed. During the healing phase, bone remodeling ensues, and consequently, peri-implant CBL is observed. Buser et al (2012) demonstrated that implant-related factors, such as material design and surface characteristics; clinician-related factors, such as surgical and prosthetic skills; and host-related factors, such as bone density and systemic and oral health, are potential causative factors for CBL. There is a substantial need to perform further studies to evaluate implant success and crestal bone changes with a low-speed drilling protocol. Therefore, the present study aimed to analyze the mean CBL in a prospective randomized clinical trial by the placement of dental implants with two drilling protocols, ie, standard and low-speed drilling protocols. The null hypothesis for the present study was that there was no statistically significant difference in mean CBL after a follow-up period of 12 months.

**MATERIALS AND METHODS**

**Study Design**

A randomized controlled clinical trial (RCT) was conducted to analyze and compare CBL around implants placed using two different protocols (standard drilling vs low-speed drilling) on patients who required dental implants to rehabilitate their partial or complete edentulism.

The present study was conducted following the Helsinki Declaration guidelines. The Medical Ethical approval for the study was obtained from the Medical Ethical Committee of Vrije University Amsterdam (Ethical approval number: 2013/151). Sample size calculation was performed with an effect size of 0.6, at a significance level of .05, and at a power of 80%. The dental implant served as the statistical unit for analysis. Twenty samples were needed for each study group. The CBL was considered the primary variable of the present study. The implant success rate was recorded as a secondary outcome variable.

**Patient Screening and Recruitment**

The patients were recruited from a university hospital (Academic Centre for Dentistry Amsterdam [ACTA], The Netherlands) from 2013 to 2016. Patients were referred by general dentists to the ACTA for placement of dental implants. All implant surgeries were accomplished at the Department of Oral Implantology and Prosthetic Dentistry at ACTA. The inclusion criteria for the patients were as follows: (1) each patient was at least 18 years of age and able to comprehend and sign a written informed consent; (2) edentulism or partial edentulism; and (3) adequate bone width/height at the time of implant placement, ie, capable of receiving at least an implant of 8 mm in length. The exclusion criteria were as follows: (1) presence of active periodontal disease; (2) unresolved extraction socket; (3) lack of motivation/compliance of the patient; (4) smoking (> 10 cigarettes per day) or tobacco chewing; (5) bruxism or any other parafunctional habits; (6) severe systemic medical condition that contraindicates surgery; and (7) pregnancy. Before inclusion in the present study, all patients were given detailed information concerning study protocol, surgical procedures, and possible risks or complications. Patients were informed of all the possible treatment options, and written informed consent was obtained. At the first appointment, an orthopantomograph (OPG) was obtained for all patients, and a comprehensive clinical examination was conducted to perform
the treatment planning for the patients. In complex cases, if required, a CBCT scan was taken. An alginate impression (Cavex CA37) was taken. The master casts were prepared using type III dental stone (Kulzer) and mounted on a semi-adjustable articulator. A surgical guide was fabricated on these mounted casts to facilitate the accurate placement of implants. A customized x-ray film holder (Rinn holder with 1 mm Dentamid Biolon, Dreve) was fabricated on the mounted casts to obtain the future radiographs at identical directions. All implant surgeries and follow-ups were performed by a single surgeon (A.T). All patient restorations (screw-retained and metal-ceramic restorations) were designed and fabricated in a similar dental laboratory (Zutphen Tandtechnisch Laboratorium). The randomization and follow-up of the study participants is presented in a flow diagram according to CONSORT 2010 (Fig 1).

**Surgical Procedure**

One hour before implant placement, a nonsteroidal anti-inflammatory medicine (600 mg Brufen) and chlorhexidine mouthwash (Corsodyl, 0.2% mouthwash, GlaxoSmithKline) was given to all patients. All surgical procedures were conducted under local anesthesia (4% articaine hydrochloride with adrenaline 1:100,000; D-S Forte Ultracain). A full-thickness flap was reflected after a midcrestal and intrasulcular incision on the adjacent teeth. All osteotomies were performed using the help of a surgical guide (prosthetic setup vacuum retainer). All the patients were randomly allocated to the standard (according to manufacturer instructions) or low-speed drilling groups by employing the closed envelope technique. Before the surgery, an envelope was randomly hand-picked and unsealed in the presence of the patient. Implants were placed using two different protocols as follows:

- **Standard drilling protocol (control group):** The implant site preparation was performed according to the manufacturer’s instructions with profuse saline irrigation. Drilling was started with a round drill (2.3 mm) and a pilot drill (2.0 mm) at 800-rpm drilling speed. Successively, the osteotomy was widened by sequential drills at different speeds as recommended by the manufacturer, ie, predrill (600 rpm), 3.3-mm drill (550 rpm), 3.8-mm drill (500 rpm), or 4.3-mm drill (400 rpm) in accordance with the final diameter of the planned dental implant.

- **Low-speed protocol (test group):** The round drill and a pilot drill were employed at a drilling speed of 800 rpm with saline irrigation. However, all following series of drills were used at 50- to 150-rpm drilling speeds without saline irrigation. The implants were placed into the prepared osteotomy by using a contra-angle handpiece or torque wrench. A healing screw or healing abutment was placed, and all surgical sites were closed with polypropylene 5/0 sutures (Hu-Friedy).

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![Fig 1 Flow diagram according to CONSORT 2010.](image-url)
Postsurgical Care and Follow-up
After the surgery, 0.2% chlorhexidine mouthwash (Corsodyl, 0.2% mouthwash, GlaxoSmithKline, three times/day for 2 weeks) and nonsteroidal analgesics (three times/day for 5 days) were prescribed to all patients. A cold pack for the first 2 hours after the surgery was recommended to all the patients to minimize postsurgical swelling. The patients with implant failures retreated after 3 months. The sutures were removed 2 weeks postoperatively. After 3 months of implant placement, the final impression was taken in custom-made dental impression trays (Dentamid Lightplast Base plates, Dreve) with polyether impression material (Impregum F, 3M ESPE). The access hole of all the screw-retained restorations was closed with Teflon tape and sealed with composite. Complete oral hygiene instructions were given to all patients.

Peri-implant Radiographic Evaluation
Radiographic evaluation for all patients was performed at the time of dental implant placement (T1) and after 1 year of implant placement (T12). To assure the reproducibility, all radiographs were taken with custom-made x-ray film holders (Rinn holder with 1 mm Dentamid Biolon, Dreve) using the long-cone paralleling technique with similar settings for each patient.31 ImageJ software version 1.47 (Wayne Rasband, National Institutes of Health) was utilized to evaluate CBLs on the mesial and distal sides of each implant. Two examiners evaluated all the radiographic images in a dark room for precise measurements. All radiographic images were assigned a unique code, and both the examiners were blinded with respect to the test or control group or time point (T1 or T12). The width of the implant was used as a reference to set the scale and calibrate the measurements, and this yielded a pixel/mm ratio. A straight line was traced at the neck of the dental implant to mark two reference points, and this line was drawn to represent zero. A perpendicular line was traced on the mesial and distal sides of the implant to measure the mean CBL. The difference between the values recorded at T12 and T1 was utilized to calculate mesial and distal CBL (Fig 2). The average of mesial and distal CBL of each dental implant was considered as a mean CBL for that particular implant for final analysis. Implant success was determined by previously published and validated criteria, ie, absence of pain and mobility around the implant, no evidence of radiolucent regions around the implant during a radiographic examination, no signs of infection or suppuration, and mean CBL that is not greater than 1.5 mm after 12 months of follow-up.

Statistical Analysis
Data analysis was performed by using SPSS 20.0 (IBM). Numerical data based on age and CBL were presented as mean and standard deviation. CBL data were explored for testing of normality by employing the Kolmogorov-Smirnov test, which showed nonnormal distribution. A 10% sample of the total sample size was randomly selected for interrater concordance, consistency, and reliability. Interrater reliability correlation was $r = 0.982$, and high internal consistency and item reliability were revealed as having an item reliability coefficient alpha $= .927$. Patient characteristics including sex, arch, and tooth positions between the control and test groups were presented into frequencies and percentages, with the chi-square test for proportions of patient characteristics between the test and control groups. The Wilcoxon Mann-Whitney $U$ test was applied to compare the significance of CBL between the control and test groups and between the mandibular and maxillary arches within the control and test groups. A
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P value ≤ .05 was considered a statistically significant result.

RESULTS

Twenty-four patients (15 men and 8 women, with a mean age of 57.5 ± 10.7 (ranging from 37 to 73) years participated in the present study after fulfilling the inclusion criteria set for this study. The patient characteristics with regard to age, arch, and tooth position were nonsignificant as presented in Table 1. Forty Camlog screw-line implants were placed, and the distribution of implants in both groups is presented in Table 2. Each patient received one or more than one implant according to the inclusion criteria of the study. All dental implants were loaded after 3 months of implant placement. All surgical sites were healed uneventfully, and no complications were recorded during the healing phase. Three implant failures were recorded (one in the standard drilling group and two in the low-speed drilling group). Two implants (one in the standard drilling group and one in the low-speed drilling group) failed to osseointegrate, even after 3 months of implant placement (implants became loose when the healing screw was removed at the time of impression taking). However, patients did not have any signs or symptoms. One implant in the low-speed drilling group, which was placed in the mandible, had an immediate failure (type 1 bone). The patient had severe pain and suppuration after 3 days of implant placement, and the implant was removed. Implant success of 95% in the standard drilling group and 90% in the low-speed drilling group was observed. In total, 3 of the 40 implants failed, giving a cumulative success rate of 92.5% after 12 months of follow-up. All failures were recorded during the osseointegration phase before the prosthetic rehabilitation phase.

The radiographs of implants placed with the standard drilling group and low-speed drilling group are presented in Fig 2. The mean CBL for the control group and test group is presented in Table 3. After 1 year of follow-up, the total mean bone loss of implants in the control group and test group was 0.206 ± 0.251 mm and 0.196 ± 0.178 mm, respectively. No significant difference could be observed between both groups (P = .885). The mean CBL for the mesial and distal sides of implants is depicted in Table 3. The mean total mesial and distal CBL between the control and test groups was also nonsignificant, with P = .443 and P = .073, respectively.

Concerning implants placed in the maxilla, the control group and test group showed a total mean CBL of 0.252 ± 0.175 mm and 0.251 ± 0.175 mm, respectively. The mean CBL for the control group and test group in the mandible was 0.173 ± 0.210 mm and 0.141 ± 0.172 mm, respectively. However, no statistically significant difference could be observed between the maxilla (P = .160) or mandible (P = .280) with either technique (Fig 3).

DISCUSSION

The present study aimed to compare the standard drilling protocol (according to the manufacturer’s instruction, ie, high drilling speed of 800 to 1,200 rpm with saline irrigation) for placement of dental implants versus low-speed drilling (drilling speed of 50 to 150 rpm) without saline irrigation. The results of the present RCT demonstrated that there was no statistically significant difference in mean CBL between the standard drilling and low-speed drilling groups after 12 months of placement of the implants. However, the implant success

<table>
<thead>
<tr>
<th>Sex</th>
<th>Control (n = 19)</th>
<th>Test (n = 20)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>13 (68.4)</td>
<td>18 (90.0)</td>
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</tr>
<tr>
<td>Female</td>
<td>6 (31.6)</td>
<td>2 (10.0)</td>
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<table>
<thead>
<tr>
<th>Age (y), mean ± SD</th>
<th>Control</th>
<th>Test</th>
<th>P value</th>
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<tr>
<td>56.8 ± 10.8</td>
<td>10 (50.0)</td>
<td>10 (50.0)</td>
<td>.561</td>
</tr>
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<thead>
<tr>
<th>Arch</th>
<th>Control (n = 19)</th>
<th>Test (n = 20)</th>
<th>P value</th>
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</thead>
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<tr>
<td>Mandible</td>
<td>11 (57.9)</td>
<td>10 (50.0)</td>
<td>.621</td>
</tr>
<tr>
<td>Maxilla</td>
<td>8 (42.1)</td>
<td>10 (50.0)</td>
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<table>
<thead>
<tr>
<th>Tooth position</th>
<th>Control (n = 19)</th>
<th>Test (n = 20)</th>
<th>P value</th>
</tr>
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<tbody>
<tr>
<td>Molar</td>
<td>13 (68.4)</td>
<td>11 (55.0)</td>
<td>.619</td>
</tr>
<tr>
<td>Premolar</td>
<td>4 (21.1)</td>
<td>7 (35.0)</td>
<td></td>
</tr>
<tr>
<td>Anterior</td>
<td>2 (10.5)</td>
<td>2 (10.0)</td>
<td></td>
</tr>
</tbody>
</table>

Values given in parentheses are percentages. Nonsignificant difference of proportions of patient characteristics between test and control groups at .05 level of significance.

<table>
<thead>
<tr>
<th>Implants placed</th>
<th>Control (n = 19)</th>
<th>Test (n = 20)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxilla</td>
<td>18</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Mandible</td>
<td>22</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total follow-up</th>
<th>Control (n = 19)</th>
<th>Test (n = 20)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>19</td>
<td>20</td>
<td></td>
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</table>
rate was higher in the standard drilling group (95%) compared with the low-speed drilling group (90%).

The amount of mean CBL recorded in the present study after 12 months of follow-up is coherent with the literature. A present literature review on microthreaded implants has observed a range of marginal bone loss between 0.05 mm and 0.9 mm after a follow-up period of 12 to 96 months.³² Besides, the outcome of the present study is in line with a recently performed RCT in which implants were placed with two different surgical techniques, ie, group 1, low-speed drilling (50 rpm) without saline irrigation; and group 2, standard drilling protocol (800 rpm) without saline irrigation. After a follow-up period of 12 months, concerning mean CBL, no statistically significant difference was observed among group 1 and group 2.²³

In oral implantology, surgical technique, implant design, implant surface characteristics, and bone regenerative material are in continuous development. For decades, the most-recommended drilling protocol for implant placement was using a drilling speed of 800 to 1,200 rpm with abundant saline irrigation to avoid excessive heat production. The concept of low-speed drilling (50 to 150 rpm) without aqueous irrigation has been reported as an alternate to the standard drilling protocol.²⁰,²¹ The low-speed drilling protocol can deliver the clinician a clear field of view, which can give the operator better control during osteotomy preparation due to a more accurate perception of the path of the drill insertion.⁹,³³ That being said, however, the major advantage of this technique is that the autogenous bone particles produced during the implant site preparation remain attached to the dental drill threads because no aqueous irrigation was utilized.⁹ The key factor for the success of autogenous grafts is to collect the bone graft with a high number of living bone-forming cells.³⁴ It has been reported that the viability of bone cells, ie, osteoblast and osteocyte cells in autogenous grafts, might decreased due to electrical instrumentation.³⁴ Furthermore, disruption of cell membranes of the bone cells that are lying on the surface or inside the bone graft might happen as a consequence of the vibrations from the drilling procedure.³⁴,³⁵ In a recent study, it was reported that the osteogenic potential of the harvested bone particles collected by employing a low-speed protocol was superior in comparison to the bone collected with bone collectors or during the standard drilling protocol. A significantly higher proliferation and differentiation rate was observed in bone particles collected by the low-speed protocol vs the standard protocol.⁹ It has been suggested that these autogenous bone chips could successfully be utilized alone or mixed with other commercially available osteoconductive bone substitutes for bone regenerative procedures in oral implantology without the need of an extra surgical site.⁹,²³

In the present study, two implant failures were observed in the low-speed drilling group, and both of the implant osteotomies were prepared in the posterior mandible in dense cortical bone (type 1). Bone density was estimated during implant surgery according to clinician tactile perception. These results might be clarified by the fact that cortical and cancellous bone differ in their thermal conductivity due to the difference in their vascularity.²⁶ Stelzle et al (2014) reported

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Table 3  Alveolar Crestal Bone Loss Around Implants (Mesial, Distal, and Mean Bone Loss) at 12 Months of Follow-up: Standard Drilling (Control) Group Versus Low-Speed Drilling (Test) Group

<table>
<thead>
<tr>
<th>Crestal bone loss (mm)</th>
<th>Standard group (control)</th>
<th>Low-speed group (test)</th>
<th>P+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total (n = 19) Maxilla (n = 8)</td>
<td>Mandible (n = 11)</td>
<td>Total (n = 20) Maxilla (n = 10)</td>
</tr>
<tr>
<td>Mesial</td>
<td>0.27 ± 0.42 0.31 ± 0.35 0.25 ± 0.48</td>
<td>0.21 ± 0.25 0.25 ± 0.29 0.17 ± 0.21</td>
<td>0.443</td>
</tr>
<tr>
<td>Distal</td>
<td>0.13 ± 0.16 0.18 ± 0.09 0.09 ± 0.12</td>
<td>0.18 ± 0.24 0.24 ± 0.27 0.11 ± 0.19</td>
<td>0.73</td>
</tr>
<tr>
<td>Mean bone loss</td>
<td>0.20 ± 0.25 0.25 ± 0.17 0.17 ± 0.21</td>
<td>0.19 ± 0.17 0.25 ± 0.17 0.14 ± 0.17</td>
<td>0.885</td>
</tr>
</tbody>
</table>

P +++ Shows significance value for mean bone loss between maxilla vs test mandible.
++ Shows significance value for total crestal bone loss between control vs test groups.

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Fig 3  Box plot of mean crestal bone loss for maxilla and mandible in standard drilling (control) group and low-speed drilling (test) group. However, no statistically significant difference could be observed between the maxilla or mandible with either technique (P > .05).
the maximum temperature rise in the cortical areas during implant site preparation in both cancellous and cortical bone.\textsuperscript{37} It has been reported that in the case of type 1 bone (dense cortical bone of low vascularity), prolonged drilling with slightly more pressure than normal, or an increased penetration depth, can result in excessive heat generation.\textsuperscript{13} This can result in the formation of a zone of necrotic bone between the surface of the implant and host bone and eventual failure of the dental implant. During implant site preparation, there is no known method to measure the pressure that is employed to the handpiece. In dense cortical bone, there is a possibility that the surgeon could unintentionally apply some extra pressure due to constant drilling speed, which can result in more frictional heat generation.\textsuperscript{13} In recent research, minimum consideration has been given to the magnitude of pressure the clinician applies on the handpiece and the consequent frictional heat generated. Eriksson and Adell supported using low pressure during osteotomy preparation; however, the amount of applied pressure was not stipulated\textsuperscript{38} because the applied force cannot be standardized due to the human factor. Matthews and Hirsch (1972) reported that the temperature documented was inversely proportional to the force applied during drilling using human cortical femoral bone.\textsuperscript{12} Brisman (1996) recently reported similar findings using bovine femoral bone.\textsuperscript{12} Therefore, the present authors recommend that surgeons should avoid using the low-speed protocol without irrigation in a high-density type 1 bone. The results of the present study are aligned with the recommendation of Flanagan (2010), who recommended the use of the low-speed drilling protocol in less-dense implant osteotomy sites.\textsuperscript{20} In addition, Trisi et al (2014) placed implants in animals with different irrigation protocols, ie, without saline irrigation, with internal or external irrigation, and an amalgamation of both. The histomorphometric analysis demonstrated bone resorption and implant failure in dense cortical bone in the study group without saline irrigation. However, all study groups employed a drilling speed of 1,000 rpm.\textsuperscript{40} Therefore, it is evident that when a drilling protocol is used without saline irrigation, the drilling speed must be reduced to minimize heat generation due to friction and consequently circumventing thermal trauma.

The main limitation of the present study was that the sample size used was not large, and patients were followed only up to 12 months. Therefore, further RCTs with greater sample sizes and extended follow-up times must be conducted to provide additional evidence and a better understanding of the effect of low speed without irrigation on mean CBL and long-term implant success.

**CONCLUSIONS**

Implants placed with low-speed drilling without saline irrigation exhibited similar mean CBL compared to implants placed with standard drilling with saline irrigation. As a higher success rate was recorded in type 1-quality bone for the standard drilling protocol, it is however recommended that surgeons should avoid using the low-speed protocol without irrigation in a high-density type 1 bone. Further RCTs should be conducted to evaluate the influence of low-speed drilling without irrigation on peri-implant bone changes and implant success, especially in type 1 bone.

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