Check for updates

Received: 10 January 2023 | Revised: 29 June 2023 | Accepted: 19 September 2023

DOI: 10.1111/clr.14189

ORIGINAL ARTICLE

CLINICAL ORAL IMPLANTS RESEARCH WILEY

Comparison of patient-centered outcomes measures between low-speed drilling without irrigation and high-speed drilling with irrigation: A randomized clinical trial

Juan Carlos Bernabeu-Mira[1] | Miguel Peñarrocha-Diago[1] | María Peñarrocha-Diago[1] | Francisco Romero-Gavilán[2] | Fabio Camacho-Alonso[3] | David Peñarrocha-Oltra[1]

[1]Oral Surgery Unit, Department of Stomatology, Faculty of Medicine and Dentistry, University of Valencia, Valencia, Spain

[2]Department of Industrial Systems Engineering and Design, Universitat Jaume I, Castello de la Plana, Spain

[3]Department of Oral Surgery, University of Murcia, Murcia, Spain

Correspondence
Juan Carlos Bernabeu-Mira, Department of Stomatology, Faculty of Medicine and Dentistry, University of Valencia, Gascó Oliag, 1, 46010 Valencia, Spain.
juan.c.bernabeu@uv.es

Abstract

Objective: To compare patient satisfaction during surgery, postoperative pain and inflammation and quality of life between high-speed drilling with irrigation and low-speed drilling without irrigation for implant bed preparation.

Materials and Methods: Sixty-six posterior single edentulous patients were included in a randomized controlled clinical trial. Implant beds were created using high-speed drilling with irrigation (control group) or low-speed drilling without irrigation (test group). Patient satisfaction during surgery (in relation to drilling-time perception, vibration, pressure, noise, comfort, and drowning sensation) and postoperative pain and inflammation were evaluated using a 100-mm visual analogue scale (VAS)-based questionnaire. Quality of life was analyzed with a Likert scale (in relation to mouth opening, chewing, speaking, sleeping, daily routine, and job). The follow-up period was 7 days.

Results: Patient satisfaction in relation to drilling-time perception, vibration, pressure, and noise did not show statistically significant differences ($p > .05$). The highest scores of drowning sensation ($p < .05$) were correlated (moderate correlation ($r = .57$)) with lowest scores of comfort ($p < .005$). Both postoperative pain and inflammation means were significantly higher in the control group than in the test group. No significant differences in quality of life were observed during the postoperative period ($p > .05$).

Conclusion: Low-speed drilling without irrigation for single implant site preparation was more comfortable for patients than high-speed drilling with irrigation, due to the correlation between important drowning sensation and low perceived comfort. Postoperative pain and inflammation were lower for low-speed drilling without irrigation. Further studies are needed to validate or refute these results.

KEYWORDS
dental implant, drilling, inflammation, low-speed, pain, quality life, satisfaction

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.
© 2023 The Authors. *Clinical Oral Implants Research* published by John Wiley & Sons Ltd.

1 | INTRODUCTION

The use of irrigation for implant drilling has been the standard technique for most implant systems since the advent of implant placement (Sutter et al., 1992). However, a new technique called low-speed drilling without irrigation has also been applied in implantology to prepare implant sites (Anitua et al., 2007). This technique uses a rotational drilling speed between 45 and 200 rpm without irrigation (Bernabeu-Mira et al., 2021).

According to a recent systematic review (Bernabeu-Mira et al., 2021), several factors have been considered in comparing the two drilling techniques: temperature change, drilling time, quantity, histomorphology and cellularity of harvested bone, histomorphology of the osteotomy, osseointegration, precision of the osteotomy, drill wear, marginal bone loss, and implant success rate.

It could be postulated that the elimination of irrigation during drilling could imply a greater bone temperature increase, with the risk of thermal osteonecrosis. However, several in vitro studies (Anitua et al., 2007; Calvo-Guirado et al., 2015; Fraguas de San José et al., 2020; Oh et al., 2016; Salomó-Coll et al., 2020) have demonstrated that this thermal increase is always lower than the critical threshold temperature exposure of 47°C during one minute (Eriksson & Albrektsson, 1983).

Clinically, the low-speed technique has demonstrated a high implant success rate similar to that obtained with standard drilling. Pellicer-Chover et al. (2017) randomly placed 30 dental implants using each drilling technique, and only one implant failure was detected in the high-speed with irrigation group. Regarding marginal bone loss, three randomized clinical trials (Abdelsattar et al., 2021; Pellicer-Chover et al., 2017; Tabassum et al., 2021) have reported no statistically significant differences between high-speed drilling with irrigation and low-speed drilling without irrigation.

The findings referred to the main clinical variables, such as peri-implant bone loss and implant success rate, seem to be confirmed (Abdelsattar et al., 2021; Pellicer-Chover et al., 2017; Tabassum et al., 2021). Furthermore, some additional advantages such as a greater quantity (Li et al., 2020) and quality (Anitua, 2018; Anitua et al., 2007; Liang et al., 2017; Tabassum et al., 2020) of collected bone chips and greater precision in the osteotomy (Fraguas de San José et al., 2020) have been described.

However, no study to date has compared patient-centered outcomes between the two techniques. Dental fear and/or dental anxiety is a common feeling reported by patients (Kvale et al., 2004), and dental implant placement seems to be one of the most unpleasant and stressful treatments (Wong & Lytle, 1991). Within equally efficient and successful techniques, dental clinicians should always look for alternatives affording lower stress, anxiety, pain, and inflammation levels for patients. Not only the difference in irrigation but also the variations in histomorphology and cellularity of the harvested bone (Liang et al., 2017; Tabassum et al., 2020) and the histomorphology of the osteotomy (Gaspar et al., 2013) justify the study of patient-centered factors between the two drilling techniques. Despite being a relatively new concept that has emerged in the last few decades, the oral health-related quality of life (OHRQoL) holds significant importance in both dental clinical practice and research. OHRQoL encompasses various dimensions, including the individual's subjective assessment of their oral health, functional and emotional well-being, satisfaction with care, and self-perception. OHRQoL is deeply intertwined with overall health and well-being (Sischo & Broder, 2011).

The objectives of this companion paper were to compare patient satisfaction during surgery, postoperative pain and inflammation, and quality of life between high-speed drilling with irrigation and low-speed drilling without irrigation for implant bed preparation.

2 | MATERIALS AND METHODS

2.1 | Study design

This paper is the first one of a series and secondary outcomes are described. The primary variable was mean marginal bone loss and together with peri-implant clinical parameters will be reported in subsequent publications as soon as the follow-up is completed.

A randomized, controlled single-blind clinical trial was conducted between February 2022 and June 2022 in the Dental Clinic of the Oral Surgery Unit (Faculty of Medicine and Dentistry, University of Valencia, Valencia, Spain). The study was carried out following the principles of the Declaration of Helsinki and was approved by the Ethics Committee of the University of Valencia (Ref.: 1937615). The present study was registered on ClinicalTrials.gov (NCT05286866). This manuscript was written according to CONSORT guidelines (Schulz et al., 2010).

Patients requiring a single dental implant in the posterior maxilla or mandible were included in the study. Each patient contributed one dental implant to the study. The patients were randomly allocated into two groups:

- Control group: implant bed prepared under high-speed drilling (800 rpm) with irrigation.
- Test group: implant bed prepared under low-speed drilling (150 rpm) without irrigation.

2.2 | Sample size calculation

This article is the first of a series studying the same sample. For this reason, although peri-implant marginal bone loss is not addressed in this study, the primary variable for calculating the sample size was mean marginal bone loss. The patient was considered as the analytical unit (1 patient provided 1 position for dental implantation). The reference article was that of Pellicer-Chover et al. (2017), where the mean marginal bone loss in similar treatment groups was 0.83 ± 0.73 mm for the test group and 0.70 ± 0.62 mm for the control group. This provided a rough estimate of the inherent variability of marginal bone loss. A minimum of 60 patients (30 per group) were needed to detect such

16000501, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/clr.14189 by Dr. Juan Carlos Bernabeu-Mira - Universitat De Valencia , Wiley Online Library on [06/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

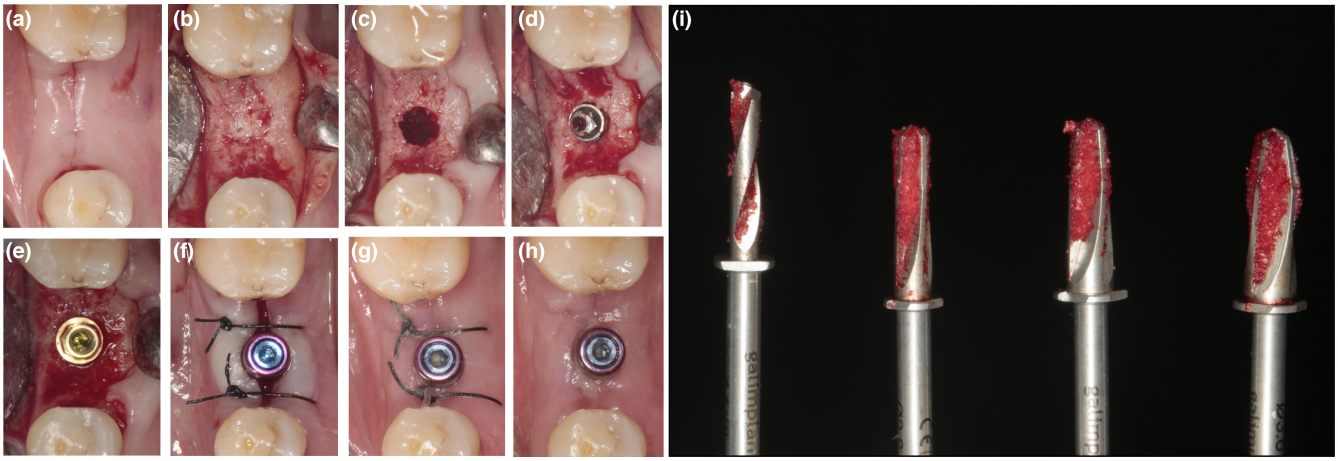

FIGURE 1 Surgical procedure for implant placement. (a) Supracrestal and intrasulcular incision. (b) Flap lift. (c) Osteotomy of the implant side. (d) Implant placement. (e) Abutment placement. (f) Suture. (g) Revision after 7 days. (h) Suture removal. (i) Appearance of surgical drills using low-speed drilling technique without irrigation.

as significantly different a mean marginal bone loss of 0.6 and 1.1 mm (large effect) in the test and control groups, respectively, with a statistical power of 80%. The difference for marginal bone loss (0.1 mm) reported by Pellicer-Chover et al. (2017) seemed to be too small to be considered as the minimum clinically relevant difference. We instead used a 0.5 mm such as minimum clinically relevant difference according to Galindo-Moreno et al. (2015) and to Díaz-Sánchez et al. (2019). The sample was increased in size by 10% to compensate for loss of power due to possible lack of follow-up or withdrawal of some patients. A total of 66 patients was calculated as the required sample size.

2.3 | Eligibility criteria

The patient inclusion criteria were (1) single posterior edentulism; (2) patients who have finished the growth phase; (3) plaque and bleeding index <25% throughout the oral cavity; (4) sufficient height and width of bone for placement of a dental implant measuring 4 mm in diameter and 8–10 mm in length, without bone regeneration procedures; (5) keratinized mucosa of at least 2 mm around the dental implant; (6) stable occlusion and a healthy periodontium; (7) no habits or medical conditions contraindicating implant surgery, such as heavy smoking, severe bruxism, pregnant or breastfeeding patients, bisphosphonate therapy, patients receiving chemotherapy or radiation therapy of the head and/or neck; and (8) uncooperative patients. The patient exclusion criteria were (1) incomplete or incorrect data collection and (2) failure to come to the control visits.

2.4 | Operational procedure

A preoperative panoramic X-ray and cone-beam computed tomography (CBCT) study was carried out in all patients using a radiographic splint with a radiopaque marker at the implant site. Bone density was calculated using the cross-section determined by the radiopaque marker. The study area recorded the same dimensions as the planned implant according to the indications of Turkyilmaz et al. (2007). The bone density measurements were analyzed using NewTom® software (Cefla S.C.) and were expressed in Hounsfield Units (HUs).

Each patient underwent prophylactic hygiene 7 days before the operation, and 2 g of amoxicillin p.o. was prescribed one hour before the intervention as prophylaxis.

All surgeries were performed by the same experienced operator (JCBM). The interventions were carried out under local anesthesia (4% articaine with 1:100,000 adrenaline) (Inibsa®) placed always by infiltration. All implants were Galimplant IPX® (Nueva Galimplant S.L.U, Sarria, Galicia, España) measuring 4 mm in diameter and 8–10 mm in length, placed 2 mm subcrestally. Surgical drills with stops (K Fres Stop®, Nueva Galimplant S.L.U, Sarria, Galicia, España) were used to prepare the osteotomies. A total of 5 surgical drills were used: pilot, 2 mm ∅, 2.6 mm ∅, 3.2 mm, and 3.6 mm ∅. Pilot drill was used under 1200 rpm with irrigation for two groups. Two-mm high anti-rotational one-piece abutments were placed immediately after implant insertion; thus, healing was nonsubmerged (Figure 1).

As postoperative medication, 1 g of paracetamol (Bexistar®, Bacino Laboratory) every 8 h was prescribed on demand. Postoperative hygiene and oral care instructions were explained to the patient. A mouthwash consisting of 0.12% chlorhexidine (GUM®, John O. Butler/Sunstar) twice daily for two weeks was also recommended. The sutures were removed 7 days after surgery. Prosthetic loading was performed 10 weeks after implant placement.

2.5 | Independent variables

Sex (male or female), age, smoking habit (0 cigarettes per day or ≤10 cigarettes per day), brushing habit (1, 2, or 3 times per day), gingiva phenotype (thin, medium, or thick), position (premolar or molar), arch (upper or lower), antagonist (edentulism, natural teeth, removable prosthesis or fixed prosthesis), dental loss cause (caries, periodontal

16000501, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/clr.14189 by Dr. Juan Carlos Bernabeu-Mira - Universitat De Valencia , Wiley Online Library on [06/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

disease or other), implant dimension (4×8 or 4×10 mm), mucosa thickness (in millimeter), and bone density (HU).

2.6 | Outcomes

2.6.1 | Patient satisfaction

Patient satisfaction was assessed using a 100-mm visual analogue scale (VAS)-based questionnaire. The first point mark indicated "worst sensation" and the last mark "best sensation". The following items were evaluated: drilling-time perception, vibration, pressure, noise, comfort, and drowning sensation during drilling.

The aforementioned items were explained to the patient before the operation. The patient was alerted at the beginning and the end of the drilling phase. The questionnaire was completed immediately after the operation, without the presence of any clinician.

2.6.2 | Postoperative pain and inflammation

The 100-mm visual analogue scale (VAS)-based questionnaire was completed by the patients to assess postoperative pain and inflammation. The first point mark (left side) corresponded to "no pain" or "no inflammation" and the last mark (right side) corresponded to "worst conceivable pain" or "worst conceivable inflammation". These items were scored by the patient for the surgical procedure and daily thereafter during 7 days. The first hours were also recorded in this order: 2, 6, and 12 h. Analgesia use (number of 1 g paracetamol tablets) was also recorded during 7 days.

2.6.3 | Quality of life

A questionnaire was completed by the patient regarding quality of life. The recorded items were mouth opening, chewing, speaking, sleeping, daily routine, and job. Items were scored by the patient postoperatively and on a daily basis for 7 days using a 5-point Likert scale: never (score = 0), hardly ever (score = 1), occasionally (score = 2), fairly often (score = 3), and very often (score = 4).

2.6.4 | Drilling time

Drilling time was measured during osteotomy perforation using a digital stopwatch, excluding the time elapsed during surgical drill changes.

2.7 | Randomization, allocation and blinding

Patients were randomized prior to the surgical procedure by simple randomization using www.randomization.com. This was a randomized, single-blind clinical trial in which the operator and the patient knew the group to which each subject had been assigned, but data collection and data analysis were blinded. The random allocation codes were sealed in sequentially numbered opaque envelopes. Allocation concealment was broken after raising of the flap, when the corresponding envelope was opened and the operator was informed whether to drill at 800 rpm with irrigation or at 150 rpm without irrigation.

2.8 | Blinding

The patient was informed that the information contained in the different questionnaires would not be accessible to the surgeon who carried out the procedure, in order to prevent bias. An independent researcher collected the questionnaires and blinded them, and another independent blinded researcher entered the questionnaire information in an MS Excel table. An independent blinded statistician was responsible for analyzing the data.

2.9 | Statistical analysis

Descriptive analysis was performed for each variable, and homogeneity tests were analyzed. Data were analyzed as a nonparametric distribution. The Mann–Whitney U-test with Bonferroni correction was applied to compare the distributions referred to satisfaction (in relation to drilling time, vibration, pressure, noise, comfort, and anxiety). The Wilcoxon test with Bonferroni correction was used to compare postoperative pain and inflammation. Nonparametric models for longitudinal data according to the Brunner–Langer method were performed for each dependent variable (satisfaction, postoperative pain, inflammation and quality of life). In turn, ANOVA-type statistics were used to evaluate the principal effects and interactions. The significance level was 5% ($\alpha = 0.05$). With a confidence level of 95%, and considering an effect size to be detected $d = 0.8$ (large), a power of 77.2% was reached for comparisons between the two study groups.

3 | RESULTS

Sixty-six patients (33 women and 33 men) between 21 and 75 years of age (mean 54.5 ± 14.4) were included in the study. Descriptive and analytical data are exposed in Table 1. All patients correctly completed the questionnaire, which was collected during the suture removal visit 7 days after surgery. There were no implant failures during the osseointegration phase.

Regarding satisfaction (Figure 2), patient perception of drilling time (control group: 30.8 ± 13.4 vs. test group: 29.6 ± 12.4), vibration (control group: 15.3 ± 11.9 vs. test group: 14.5 ± 10.5), pressure (control group: 14.7 ± 11 vs. test group: 16.7 ± 11.2), and noise (control group: 19.2 ± 16.6 vs. test group: 14.4 ± 11) showed no statistically significant differences between the two groups ($p < .005$). However,

16000501, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/clr.14189 by Dr. Juan Carlos Bernabeu-Mira - Universitat De Valencia , Wiley Online Library on [06/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1 Descriptive data for each variable at patient level. Homogeneity, effect of independent variable, and statistical test.

Variable	Categories	Control *n* (%) or Δ ± SD	Test *n* (%) or Δ ± SD	Sample homogenety		Effect of independent variables		
				p value	Statistic test	Pain (p)	Inflammation (*p*)	Statistic test
Sex	Male	17 (51.5)	16 (48.5)	.806	Chi^2	0.311	.959	MW
	Female	16 (48.5)	17 (51.5)					
Age	—	53 ± 14.5	56 ± 14.4	.422	MW	0.548	.185	MW
Smoking habit	0 cig/day	27 (81.1)	27 (81.8)	1.000	Chi^2	0.954	.566	MW
	≤10 cig/day	6 (18.2)	6 (18.2)					
Brushing habit	1 per day	2 (6.1)	2 (6.1)	.460	Chi^2	0.595	.847	MW
	2 per day	16 (48.5)	13 (39.4)					
	3 per day	15 (45.5)	18 (54.5)					
Gingiva phenotype	Thin	5 (15.2)	3 (9.1)	.672	Chi^2	0.326	.152	KW
	Medium	23 (69.7)	26 (78.8)					
	Thick	5 (15.2)	4 (12.1)					
Position	Premolar	20 (60.6)	21 (63.6)	.800	Chi^2	0534	.328	MW
	Molar	13 (39.4)	12 (36.4)					
Arch	Upper	15 (45.5)	16 (48.5)	.850	Chi^2	0.653	.995	MW
	Lower	18 (54.5)	17 (51.5)					
Antagonist	Edentulism	0 (0)	0 (0)	.427	FIS	0.662	.200	MW
	Natural teeth	28 (84.8)	31 (93.9)					
	Removible prosthesis	0 (0)	0 (0)					
	Fixed prosthesis	5 (15.2)	2 (6.1)					
Dental loss cause	Periodontal disease	0 (0)	0 (0)	1.000	FIS	0.745	.526	MW
	Caries	31 (93.9)	32 (96.9)					
	Other	2 (6.1)	1 (3.1)					
Implant dimension	4 × 8 mm	17 (51.5)	18 (54.5)	.805	Chi^2	0.658	.954	MW
	4 × 10 mm	16 (48.5)	15 (45.5)					
Mucosa thickness	—	2.4 ± 1.5	2.3 ± 0.7	.481	MW	0.009	.040	MW
Bone density	—	739.3 ± 328.6	723.3 ± 319,3	.724	MW	0.086	.030	KW

Abbreviations: Δ, media; *n*, sample number; SD, standard deviation.

significantly greater drowning sensation (control group: 26.5 ± 24.2 vs. test group: 11.2 ± 11.4) was perceibed by the patients in the control group ($p < .001$) and significantly greater comfort (control group: 63.2 ± 12 vs. test group: 77.1 ± 10.8) was perceived by the patients in the test group ($p < .001$). Drowning sensation and comfort were moderate correlated ($r = .57$), as comfort decreased while drowning sensation increased in a significant way ($p < .001$).

Regarding postoperative pain (Figure 3), the maximum pain level was reached 12 h after implant placement in both groups. There was a statistically significant variation between the two groups ($p < .05$), overall, and also at the different timepoints during follow-up, with a non-identical decreasing pattern for both of them ($p < .001$). The mean pain was 9.85 ± 7.15 for control group and 4.98 ± 4.19 for test group ($p < .05$). The test group showed significantly ($p < .05$) lower pain levels at 2, 6, and 12 h compared with the control group (Table 2).

Regarding postoperative inflammation (Figure 4), the peak was reached on the second day after implant placement in both groups. There were significant differences in postoperative inflammatory levels between the two techniques ($p < .05$), overall, and also at the different timepoints during follow-up. The mean inflammation was 12.12 ± 8.76 for control group and 7.3 ± 6 for test group ($p < .05$). The test group showed significantly ($p < .05$) lower inflammation levels at the second day compared with the control group (Table 3).

Analgesia intake was higher on the first day in both groups. During the first day, up to 80% of the patients needed at least two tablets—this percentage dropping to 32.7% on day 2 and 7.6% on day 3. The percentage decreased until day 5, when no patients needed paracetamol. There were no statistically significant differences between the groups in terms of analgesic use ($p > .05$).

Each parameter referred to quality of life (Table 3) improved during follow-up in both groups ($p < .001$). No statistically significant differences were observed between the groups at any timepoint or for any of the addressed parameters: mouth opening ($p = .662$),

16000501, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/clr.14189 by Dr. Juan Carlos Bernabeu-Mira - Universitat De Valencia , Wiley Online Library on [06/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

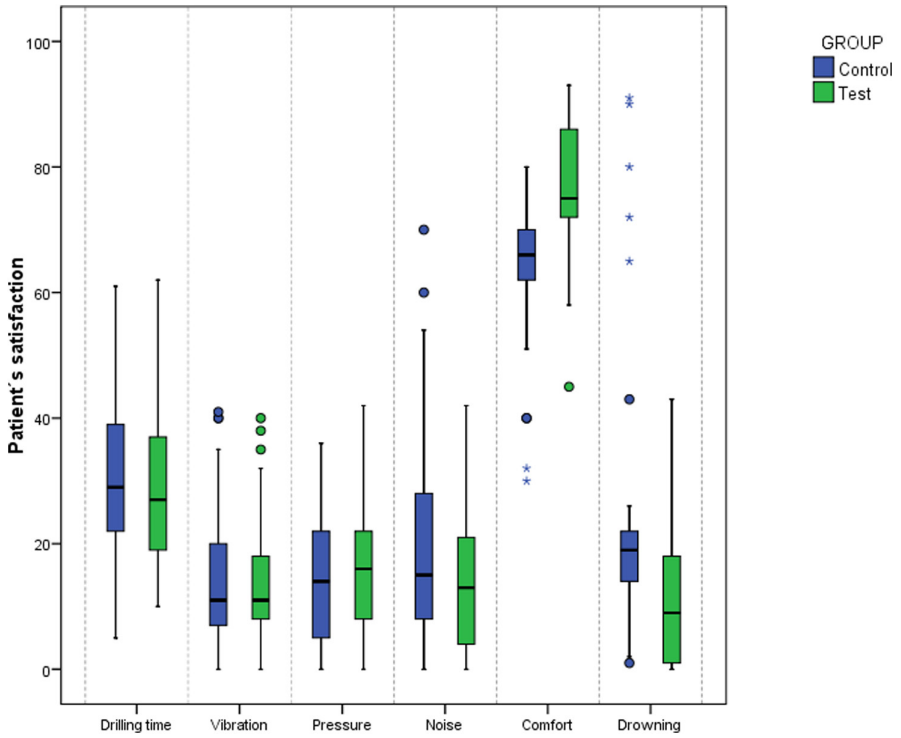

FIGURE 2 Patient satisfaction referred to drilling time, vibration, pressure, noise, comfort, and drowning sensation.

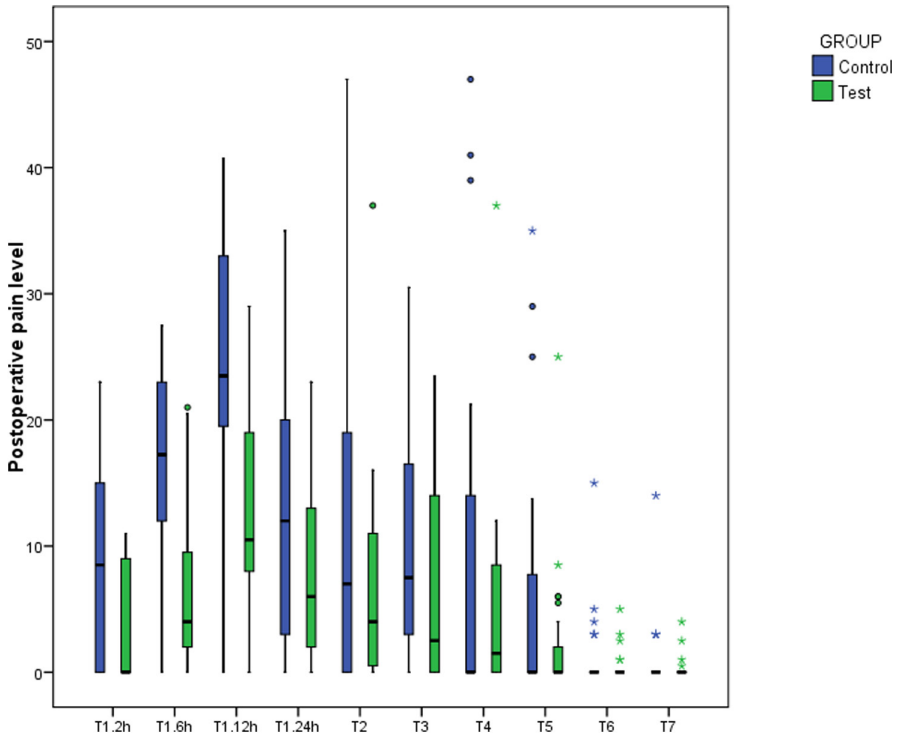

FIGURE 3 Postoperative pain.

TABLE 2 Scores (mean ± standard deviation) corresponding to postoperative pain during follow-up.

	T1.2 h	T1.6 h	T1.12 h	T1.24 h	T2	T3	T4	T5	T6	T7
Control group	9 ± 8*	16.1 ± 8.1*	24.5 ± 10*	13.1 ± 10.9	11.3 ± 12.8	11 ± 9.4	7.3 ± 13	4.5 ± 9.1	1 ± 2.9	0.8 ± 2.6
Test group	3.3 ± 4.5*	6.5 ± 6.4*	12.8 ± 7.8*	7.4 ± 6.5	6.3 ± 7.8	6.7 ± 7.6	4.1 ± 7.1	2 ± 4.7	0.4 ± 1.1	0.2 ± 0.8

Note: T1.2h (2 h postsurgery); T1.6h (6 h postsurgery); T1.12h (12 h postsurgery); T1.24h (24 h postsurgery); T2 (day 2 postsurgery); T3 (day 3 postsurgery); T4 (4 postsurgery); T5 (day 5 postsurgery); T6 (day 6 postsurgery); T7 (day 7 postsurgery). "*$p \leq .050$".

16000501, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/clr.14189 by Dr. Juan Carlos Bernabeu-Mira - Universitat De Valencia , Wiley Online Library on [06/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

FIGURE 4 Postoperative inflammation.

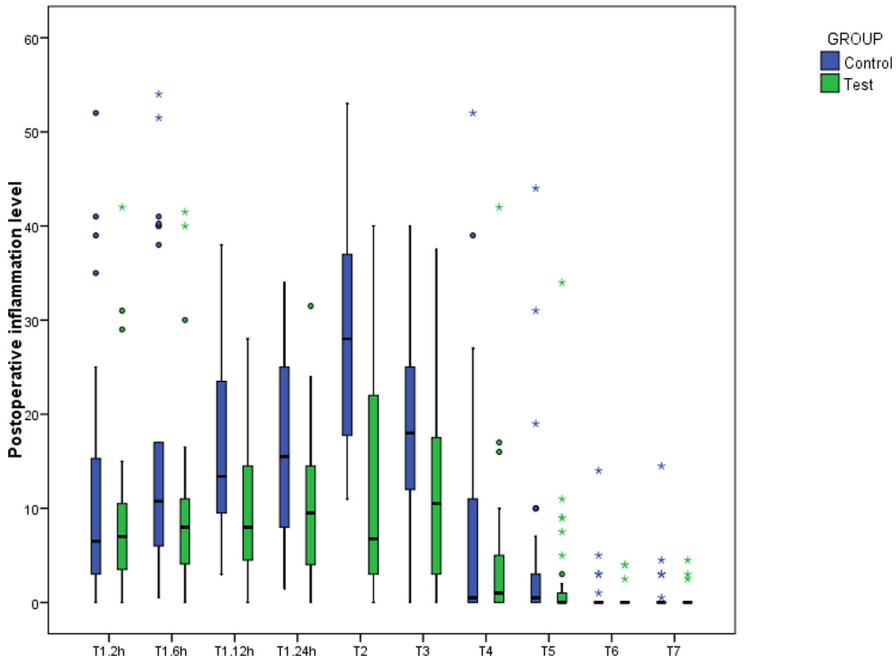

TABLE 3 Scores (mean ± standard deviation) corresponding to postoperative inflammation during the follow-up period.

	T1.2h	T1.6h	T1.12h	T1.24h	T2	T3	T4	T5	T6	T7
Control group	11.3 ± 13.2	15.9 ± 15.6	16.6 ± 10.2	17 ± 10	28.7 ± 13.3*	18.6 ± 11.6	6.9 ± 12.2	4.5 ± 9.7	0.9 ± 2.6	0.9 ± 2.7
Test group	8.7 ± 9.1	10 ± 9.7	10.2 ± 7.3	10.9 ± 7.9	13.6 ± 13.1*	12.2 ± 10.5	4.3 ± 8	2.5 ± 6.4	0.3 ± 1	0.3 ± 1

Note: T1.2h (2 h postsurgery); T1.6h (6 h postsurgery); T1.12h (12 h postsurgery); T1.24h (24 h postsurgery); T2 (day 2 postsurgery); T3 (day 3 postsurgery); T4 (4 postsurgery); T5 (day 5 postsurgery); T6 (day 6 postsurgery); T7 (day 7 postsurgery). "*$p \leq .050$".

chewing ($p = .980$), speaking ($p = .112$), sleeping ($p = .242$), daily routine ($p = .506$), or job ($p = .548$).

The drilling time values showed statistically significant differences ($p < .001$) between the control group (18.5 ± 2.5 s) and the test group (24.9 s ± 4.2 s).

4 | DISCUSSION

The present publication is a companion paper which reports secondary outcomes (patient satisfaction, postoperative pain, inflammation, and quality of life) of a study comparing high-speed drilling with irrigation and low-speed drilling without irrigation for implant bed preparation. To our knowledge (Bernabeu-Mira et al., 2021), no previous studies have compared these drilling techniques in relation to patient-centered outcomes.

The vibration, noise, and pressure levels showed no statistically significant differences between the two groups. However, drowing sensation and comfort were statistically significant different. The drowing sensation and comfort showed a moderate inverse correlation, with statistically significant differences. The patients who suffered the highest levels (outliners) of drowning sensation strongly felt the lowest levels of comfort. Patient perception of drilling time did not differ significantly between the two groups, although there was a statistically significant difference of 6.4 seconds in real drilling time.

In relation to postoperative pain, several studies of dental implants without regenerative procedures (Al-Khabbaz et al., 2007; González-Santana et al., 2005; Muller & Ríos Calvo, 2001) reported pain to peak during the first day. This is consistent with our own study, in which maximum pain levels were reported 12 h after implant placement. It should be mentioned, however, that the timepoints for recording pain primarily involved intervals of days not hours as in some studies (Al-Khabbaz et al., 2007; Muller & Ríos Calvo, 2001). Several studies have found self-reported pain to be of low-mild intensity (Al-Khabbaz et al., 2007; González-Santana et al., 2005; Muller & Ríos Calvo, 2001), as in the present study.

In relation to postoperative inflammation, a clinical study (González-Santana et al., 2005) involving 41 patients with the placement of 131 implants reported a moderate postoperative inflammatory peak after 48 h in 48.8% of the cases. In the present study, the inflammatory peak was consistent with the aforementioned study, but the intensity was mild because only one dental implant was placed per patient. In single-tooth implant placement, 24 patients reported peak inflammation at 24 h postsurgery, followed by a significant decrease over three consecutive days until the end of follow-up (Spin-Neto et al., 2014).

The present study recorded significant differences in total mean postoperative pain and inflammation and in the peak intensities between the two groups. However, there are no studies with which to compare these data, and so further research is needed to confirm the results obtained.

16000501, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/clr.14189 by Dr. Juan Carlos Bernabeu-Mira - Universitat De Valencia , Wiley Online Library on [06/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Postoperative pain and inflammation were two strongly related processes, and are secondary to surgical tissue injury (Bryce et al., 2014). A number of inflammatory factors are involved, including prostaglandins that sensitize the peripheral nerve endings (slow unmyelinated C-fibers) and cause electrophysiological changes that result in pain sensation (Garg, 2011). Such pain- and inflammation-mediating prostaglandins are derived from destruction of the cellular lipid (Bryce et al., 2014). The statistically significant findings obtained in terms of postoperative pain and inflammation could be consistent with the histological data (Gaspar et al., 2013; Tabassum et al., 2020). In this regard, Gaspar et al. (2013) studied 36 osteotomies of rabbit tibias under the light microscope. In the control group (drilling speed 800 rpm with irrigation), greater destruction of trabecular bone was detected, specifically in the form of splinters, bleeding and disruption of the bone marrow. In the test group (drilling speed 50 rpm without irrigation), none of the mentioned damage features were observed. Such bone destruction in the control group could explain the greater pain and inflammatory reaction which the patients experienced in the present study. While there are no clinical studies reporting histomorphologic findings at the osteotomy site, several human studies have performed histomorphologic analyses of collected bone chips. In this regard, Tabassum et al. (2020) directly compared the bone fragments collected among the drill flutes with the two drilling techniques and reported statistically significant differences in terms of cell proliferation and differentiation intensity.

No studies to date have compared patient-centered outcomes between different surgical drilling techniques. However, piezosurgery and drilling technique were compared in a split-mouth study involving 75 patients to assess possible differences related to pain (Maglione et al., 2019). Both analgesic drug use and pain level were significantly greater in drill-inserted implants than in piezoelectric-inserted implants.

In the present study, the real drilling time was significantly longer in the test group than in the control group, in concordance with the observations of two previous studies (Calvo-Guirado et al., 2015; Oh et al., 2016). The in vitro experiment (Oh et al., 2016), which used one drill for each group, took 2.5 times longer, while the nonclinical animal experiment (Calvo-Guirado et al., 2015) involving four drills for the control group and two drills for the test group, took 2.4 times longer—including the time needed to change the drill. In the present study, drilling time in the test group was 1.35 times longer than in the control group. A possible explanation for these smaller differences might be that our study made use of multiple drills (5 to be precise) in both groups. Another explanation might be the different rotational speeds used in the studies. For the test group, 150 rpm was selected in our study, while 50 rpm and 50–100 rpm were used by Oh et al. (2016) and Calvo-Guirado et al. (2015), respectively. In turn, for the control group, 800 rpm was selected in our study, while 1500 rpm and 400–1200 rpm were used by Oh et al. (2016) and Calvo-Guirado et al. (2015), respectively.

None study compared the quality of life between both techniques. The results of the present study did not report statistically significant differences. The questionnaire structure was drawn from studies (Del Fabbro et al., 2012; Soto-Peñaloza et al., 2020) that analyzed quality of life for surgical techniques on days immediately following surgery. A nonvalidated scale was used to evaluate quality of life because references (Del Fabbro et al., 2012; Soto-Peñaloza et al., 2020) were found in the literature to compare surgical techniques that reached the same final result such as in the present study.

As limitations of our study, the sample size was calculated for marginal bone loss (the study's primary outcome), not for patient-centered outcome measures (secondary outcomes). For this reason, these results were interpreted with caution. The sample size of future studies on the topic should be calculated using patient-centered outcome measures as primary variables. More randomized clinical trials and especially split-mouth studies and patients with partial and total edentulism are necessary to confirm the results obtained.

5 | CONCLUSIONS

Within the limitations of the present study, low-speed drilling without irrigation for single implant site preparation seems to be more comfortable for patients than high-speed drilling with irrigation. Patients reported less postoperative pain and inflammation with low-speed drilling without irrigation than with high-speed drilling with irrigation. Patient quality of life and analgesic drug use showed no statistically significant differences between the two groups. PROMs were a secondary outcome in this manuscript, so these results must be interpreted with caution. Further studies on the topic in which PROMs are used as primary variables are needed to confirm or refute these findings.

AUTHOR CONTRIBUTIONS

Conception and design of this study Juan Carlos Bernabeu-Mira, Miguel Peñarrocha-Diago, María Peñarrocha-Diago, Fabio Camacho-Alonso, and David Peñarrocha-Oltra. Performing surgeries and prosthesis: Juan Carlos Bernabeu-Mira. Data collection: Fabio Camacho-Alonso and Francisco Romero-Gavilán. Writing—original draft preparation: Juan Carlos Bernabeu-Mira. Review and editing; Miguel Peñarrocha-Diago, María Peñarrocha-Diago, and David Peñarrocha-Oltra. Supervision: Miguel Peñarrocha-Diago. Project administration: David Peñarrocha-Oltra.

ACKNOWLEDGMENTS

D. Juan Luís Gómez Martínez for performing an independent and blinded statistic data analysis. State Program, Scholarship for Training of University Teacher Training (FPU18/02254) of Juan Carlos Bernabeu Mira.

FUNDING INFORMATION

The study was not funded by anyone.

16000501, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/clr.14189 by Dr. Juan Carlos Bernabeu-Mira - Universitat De Valencia , Wiley Online Library on [06/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

CONFLICT OF INTEREST STATEMENT

There is no interest or relationship, financial or otherwise, that could be perceived as influencing the objectivity of any of the authors.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

CLINICAL TRIAL REGISTRATION

Unique identification number: NCT05286866.

ORCID

Juan Carlos Bernabeu-Mira https://orcid.org/0000-0003-1268-5361
Fabio Camacho-Alonso https://orcid.org/0000-0002-3739-1792

REFERENCES

Abdelsattar, M., El Khader, A., & Abdel Rassoul, M. (2021). Assessment of low-speed drilling without irrigation versus convencitonal drilling with irrigation regarding heat generation and peri-implant marginal bone loss (randomized clinical trial). *Alexandria Dental Journal*, *46*(2), 33–38.

Al-Khabbaz, A. K., Griffin, T. J., & Al-Shammari, K. F. (2007). Assessment of pain associated with the surgical placement of dental implants. *Journal of Periodontology*, *78*(2), 239–246. https://doi.org/10.1902/jop.2007.060032

Anitua, E. (2018). Biological drilling: Implant site preparation in a conservative manner and obtaining autogenous bone grafts. *Balkan Journal of Dental Medicine*, *22*, 98–101.

Anitua, E., Carda, C., & Andia, I. (2007). A novel drilling procedure and subsequent bone autograft preparation: A technical note. *International Journal of Oral and Maxillofacial Implants*, *22*(1), 138–145.

Bernabeu-Mira, J. C., Soto-Peñaloza, D., Peñarrocha-Diago, M., Camacho-Alonso, F., Rivas-Ballester, R., & Peñarrocha-Oltra, D. (2021). Low-speed drilling without irrigation versus conventional drilling for dental implant osteotomy preparation: A systematic review. *Clinical Oral Investigations*, *25*(7), 4251–4267. https://doi.org/10.1007/s00784-021-03939-z

Bryce, G., Bomfim, D. I., & Bassi, G. S. (2014). Pre- and post-operative management of dental implant placement. Part 1: Management of post-operative pain. *British Dental Journal*, *217*(3), 123–127. https://doi.org/10.1038/sj.bdj.2014.650

Calvo-Guirado, J. L., Delgado-Peña, J., Maté-Sánchez, J. E., Mareque Bueno, J., Delgado-Ruiz, R. A., & Romanos, G. E. (2015). Novel hybrid drilling protocol: Evaluation for the implant healing—Thermal changes, crestal bone loss, and bone-to-implant contact. *Clinical Oral Implants Research*, *26*(7), 753–760. https://doi.org/10.1111/clr.12341

Del Fabbro, M., Ceresoli, V., Lolato, A., & Taschieri, S. (2012). Effect of platelet concentrate on quality of life after periradicular surgery: A randomized clinical study. *Journal of Endodontics*, *38*(6), 733–739. https://doi.org/10.1016/j.joen.2012.02.022

Díaz-Sánchez, M., Soto-Peñaloza, D., Peñarrocha-Oltra, D., & Peñarrocha-Diago, M. (2019). Influence of supracrestal tissue attachment thickness on radiographic bone level around dental implants: A systematic review and meta-analysis. *Journal of Periodontal Research*, *54*(6), 573–588. https://doi.org/10.1111/jre.12663

Eriksson, A. R., & Albrektsson, T. (1983). Temperature threshold levels for heat-induced bone tissue injury: A vital-microscopic study in the rabbit. *The Journal of Prosthetic Dentistry*, *50*(1), 101–107. https://doi.org/10.1016/0022-3913(83)90174-9

Fraguas de San José, L., Ruggeri, F. M., Rucco, R., Zubizarreta-Macho, Á., Alonso Pérez-Barquero, J., Riad Deglow, E., & Hernández Montero, S. (2020). Influence of drilling technique on the radiographic, thermographic, and geomorphometric effects of dental implant drills and osteotomy site preparations. *Journal of Clinical Medicine*, *9*(11), E3631. https://doi.org/10.3390/jcm9113631

Galindo-Moreno, P., León-Cano, A., Ortega-Oller, I., Monje, A., O' Valle, F., & Catena, A. (2015). Marginal bone loss as success criterion in implant dentistry: Beyond 2 mm. *Clinical Oral Implants Research*, *26*(4), e28–e34. https://doi.org/10.1111/clr.12324

Garg, A. (2011). Analgesia in implant dentistry. *Dental Implantology Update*, *22*(6), 41–45.

Gaspar, J., Borrecho, G., Oliveira, P., Salvado, F., & Martins dos Santos, J. (2013). Osteotomy at low-speed drilling without irrigation versus high-speed drilling with irrigation: An experimental study. *Acta Medica Portuguesa*, *26*(3), 231–236.

González-Santana, H., Peñarrocha-Diago, M., Guarinos-Carbó, J., & Balaguer-Martínez, J. (2005). Pain and inflammation in 41 patients following the placement of 131 dental implants. *Medicina Oral, Patologia Oral y Cirugia Bucal*, *10*(3), 258–263.

Kvale, G., Berggren, U., & Milgrom, P. (2004). Dental fear in adults: A meta-analysis of behavioral interventions. *Community Dentistry and Oral Epidemiology*, *32*(4), 250–264. https://doi.org/10.1111/j.1600-0528.2004.00146.x

Li, W. T., Li, P., Piao, M. Z., Zhang, F., & Di, J. (2020). Study on bone volume harvested from the implant sites with different methods. *Beijing Da Xue Xue Bao.Yi Xue Ban = Journal of Peking University.Health Sciences*, *52*(1), 103–106. https://doi.org/10.19723/j.issn.1671-167x.2020.01.016

Liang, C., Lin, X., Wang, S. L., Guo, L. H., Wang, X. Y., & Li, J. (2017). Osteogenic potential of three different autogenous bone particles harvested during implant surgery. *Oral Diseases*, *23*(8), 1099–1108. https://doi.org/10.1111/odi.12704

Maglione, M., Bevilacqua, L., Dotto, F., Costantinides, F., Lorusso, F., & Scarano, A. (2019). Observational study on the preparation of the implant site with piezosurgery vs. drill: Comparison between the two methods in terms of postoperative pain, surgical times, and operational advantages. *BioMed Research International*, *2019*, 8483658. https://doi.org/10.1155/2019/8483658

Muller, E., & Ríos Calvo, M. P. (2001). Pain and dental implantology: Sensory quantification and affective aspects. Part I: At the private dental office. *Implant Dentistry*, *10*(1), 14–22. https://doi.org/10.1097/00008505-200101000-00007

Oh, J. H., Fang, Y., Jeong, S. M., & Choi, B. H. (2016). The effect of low-speed drilling without irrigation on heat generation: An experimental study. *Journal of the Korean Association of Oral and Maxillofacial Surgeons*, *42*(1), 9–12. https://doi.org/10.5125/jkaoms.2016.42.1.9

Pellicer-Chover, H., Peñarrocha-Oltra, D., Aloy-Prosper, A., Sanchis-Gonzalez, J. C., Peñarrocha-Diago, M. A., & Peñarrocha-Diago, M. (2017). Comparison of peri-implant bone loss between conventional drilling with irrigation versus low-speed drilling without irrigation. *Medicina Oral, Patologia Oral y Cirugia Bucal*, *22*(6), e730–e736. https://doi.org/10.4317/medoral.21694

Salomó-Coll, O., Auriol-Muerza, B., Lozano-Carrascal, N., Hernández-Alfaro, F., Wang, H. L., & Gargallo-Albiol, J. (2020). Influence of bone density, drill diameter, drilling speed, and irrigation on temperature changes during implant osteotomies: An in vitro study. *Clinical Oral Investigations*, *25*, 1047–1053. https://doi.org/10.1007/s00784-020-03398-y

Schulz, K. F., Altman, D. G., Moher, D., & CONSORT Group. (2010). CONSORT 2010 statement: Updated guidelines for reporting parallel group randomised trials. *Plos Med*, *24,7*(3), e1000251. https://doi.org/10.1371/journal.pmed.1000251

Sischo, L., & Broder, H. L. (2011). Oral health-related quality of life: What, why, how, and future implications. *Journal of Dental Research*, *90*(11), 1264–1270. https://doi.org/10.1177/0022034511399918

16000501, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/clr.14189 by Dr. Juan Carlos Bernabeu-Mira - Universitat De Valencia , Wiley Online Library on [06/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Soto-Peñaloza, D., Peñarrocha-Diago, M., Cervera-Ballester, J., Peñarrocha-Diago, M., Tarazona-Alvarez, B., & Peñarrocha-Oltra, D. (2020). Pain and quality of life after endodontic surgery with or without advanced platelet-rich fibrin membrane application: A randomized clinical trial. *Clinical Oral Investigations*, *24*(5), 1727–1738. https://doi.org/10.1007/s00784-019-03033-5

Spin-Neto, R., Pontes, A. E., Wenzel, A., & Sakakura, C. E. (2014). Patient discomfort following single-tooth implant placement: A randomized controlled trial of immediate vs. conventional tooth restoration. *Oral Health and Dental Management*, *13*(2), 441–445.

Sutter, F., Krekeler, G., Schwammberger, A. E., & Sutter, F. J. (1992). Atraumatic surgical technique and implant bed preparation. *Quintessence International (Berlin, Germany: 1985)*, *23*(12), 811–816.

Tabassum, A., Kazmi, F., Wismeijer, D., Siddiqui, I. A., & Tahmaseb, A. (2021). A prospective randomized clinical trial on radiographic crestal bone loss around dental implants placed using two different drilling protocols: 12-month follow-up. *The International Journal of Oral & Maxillofacial Implants*, *36*(6), e175–e182. https://doi.org/10.11607/jomi.9029

Tabassum, A., Wismeijer, D., Hogervorst, J. M. A., & Tahmaseb, A. (2020). Comparison of proliferation and differentiation of human osteoblast-like cells harvested during implant osteotomy preparation using two different drilling protocols. *International Journal of Oral and Maxillofacial Implants*, *35*(1), 141–149. https://doi.org/10.11607/jomi.7648

Turkyilmaz, I., Tumer, C., Ozbek, E. N., & Tözüm, T. F. (2007). Relations between the bone density values from computerized tomography, and implant stability parameters: A clinical study of 230 regular platform implants. *Journal of Clinical Periodontology*, *34*(8), 716–722. https://doi.org/10.1111/j.1600-051X.2007.01112.x

Wong, M., & Lytle, W. R. (1991). A comparison of anxiety levels associated with root canal therapy and oral surgery treatment. *Journal of Endodontics*, *17*(9), 461–465. https://doi.org/10.1016/S0099-2399(07)80138-5

How to cite this article: Bernabeu-Mira, J. C., Peñarrocha-Diago, M., Peñarrocha-Diago, M., Romero-Gavilán, F., Camacho-Alonso, F., & Peñarrocha-Oltra, D. (2024). Comparison of patient-centered outcomes measures between low-speed drilling without irrigation and high-speed drilling with irrigation: A randomized clinical trial. *Clinical Oral Implants Research*, *35*, 21–30. https://doi.org/10.1111/clr.14189

16000501, 2024, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/clr.14189 by Dr. Juan Carlos Bernabeu-Mira - Universitat De Valencia , Wiley Online Library on [06/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License