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Assessment of Crestal Bone Loss and Implant Stability of Implant Drilling Protocol at Low speed without Irrigation versus Conventional Drilling Protocol

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ABSTRACT

Aim: This study assesses crestal bone loss surrounding dental implants, primary and secondary stability in sites prepared by conventional versus low speed drilling protocol. Material and Methods: Ten patients received 20 implants to restore an edentulous area in the lower posterior mandibular area. Patients were blindly divided into a control and study group. In the control group, sequential drilling was performed at 1,200 rpm and torque of 30 Ncm with irrigation till reaching the planned length and diameter. In the Study group, sequential drilling was performed at 150 rpm and torque of 50 Ncm without irrigation till reaching the planned length and diameter. Digital periapical radiographs were taken immediately postoperative, after 3 and 6 months to assess the crestal bone loss. Osstell® was used to quantify the implant stability; the primary stability was measured right after implant placement and the secondary stability was assessed after 3 months. Results: There was no statistically significant difference in crestal bone loss between both groups. The results of the primary stability of the control group showed a greater value than that of the study group with a statistically significant difference, while there was no statistically significant difference in the secondary stability between groups. Conclusion: Within the limitations of this study, drilling at low speed without irrigation is a successful implant site preparation technique for dental implants.

1. INTRODUCTION

Several techniques of implant site preparation have been introduced. The osteotome technique was introduced to enhance the stability of implants. Bone is compressed laterally and apically at the implant site by using osteotomes with increasingly larger diameters[1]. The incremental technique, sometimes referred to as the conventional drilling technique, was first presented by Brånemark and is today the industry standard in the majority of implant systems. It is based on high speed drilling at 1,500 rpm Drilling is done in phases, starting with modest diameters and progressing incrementally to greater diameters. During the entirety of the implant bed preparation, the process must be carried out with irrigation[2]. The simplified drilling, where the procedure starts by a pilot drill and ends with a drill that is sized to fit the implant diameter[3]. The Single bur drilling technique, which allows in bone types II, III, and IV for just one drilling procedure and in bone type I, up to two drilling stages with two progressively larger diameters. It is accomplished with specially constructed cylinder-tapered and four-bladed drills. External irrigation is used during the drilling operation, which is carried out at a speed of 1,500 rpm[4]. The piezoelectric surgery is a different method for implant placement that makes a number of claims about how it is superior to traditional methods, including better accuracy, more selective cutting, less harm to soft tissues, less bleeding, better visibility in the operating field, and the absence of overheating[5]. The Magnetic Mallet, a surgical medical tool with various inserts, can be used to prepare the implant site. Bone can be compressed by the Magnetic Mallet, leading to bone densification[6].

A drilling protocol founded on biological criteria was presented by Anitua et al. A pilot drill at 800 rpm with irrigation initiates the drilling process, which is then followed by drills of different sizes and shapes at low speeds (20 to 80 rpm) without irrigation[7]. The low speed drilling protocol provides a few benefits over the conventional drilling process. Firstly, the unnecessity for irrigation due to the less heat produced by drilling at low speed. Drilling at low speeds without irrigation did not result in overheating, according to experimental investigations that measured the temperature change[8–11]. 47ºC is the crucial temperature for the onset of bone necrosis[12]. Another benefit is the ability to salvage drill-cut bone without it being contaminated by saliva for use in autografts[7,11,13]. Moreover, low speed drilling can give the operator more accurate information about the drills' route, allowing for adjustments as needed[10]. At the histological level for the cancellous bone there was observed greater bone destruction in defects produced at 800 rpm with irrigation, with the presence of splinters, bleeding and disruption of bone marrow[14].

2. MATERIALS AND METHODS

Patient selection

There were 20 implants placed altogether in 10 patients to restore an edentulous area in the lower posterior mandibular area. Future University in Egypt's Oral and Maxillofacial Surgery Unit served as the source for participants. The Ethics Committee of the Faculty of Oral and Dental Medicine at the Future University in Egypt reviewed the study's design. After being fully informed about the study and prior to inclusion, a consent document was submitted for the patients' signature. For the patients, the following criteria applied: 1) Age: 20-40 years old patients; 2) Tooth extraction at the site of implant placement was done at least 3 months before; 3) Patients having sufficient height (>10 mm) and width (>5 mm) which can accommodate for implant placement. The exclusion criteria were: 1) Smokers, poor oral hygiene, severe bruxism or active periodontal disease; 2) Any medical condition or medication contracting implant surgery; 3) Intra-bony lesions or the need for bone grafting; 4) Pregnancy.

Preoperative preparations

Clinical examination was performed followed by obtaining a panoramic x-ray for early scouting and screening of the patient's bone to exclude any pathological lesions or periapical pathosis. Dental impressions were taken to fabricate study casts. The patient was instructed for proper oral hygiene measures. Pre-operative CBCT was obtained to evaluate the available bone to accommodate for dental implant placement and planning for the future dental implant was performed to ensure proper implants selection (Fig.1).

Surgical phase

On the day of the operation antiseptic mouthwash was used to rinse the patient's mouth and the operation was begun by the administration of local anesthesia utilizing infiltration technique buccally and lingually to add more safety measures to avoid injury of the inferior alveolar nerve (Articaine 4% with epinephrine). Blade number 15 was used to make a crestal incision, and a mucoperiosteal elevator was used to elevate a full mucoperiosteal flap. Blind grouping of patients into two groups—a control group and a study group—was used. The control group consisted of sequential drilling at 1,200 rpm and torque of 30 Ncm with irrigation till reaching the planned length and diameter. The study group consisted of sequential drilling at 150 rpm and torque of 50 Ncm without irrigation till reaching the planned length and diameter. Both groups were operated by the same hand piece. The time of the operation was recorded in seconds using a stopwatch to compare the duration of the operation of both techniques. Bone sounding was performed on all walls to ensure that there was no cortical perforation. Then the implant was manually placed using the torque wrench. Then the Suturing was done in an interrupted manner using vicryl 3-0. At the end of the visit the patient was informed by the post-operative care including medications and instructions and recalled after a week for follow up of proper wound healing and removal of the sutures (Fig.2).

Loading phase

The patient was recalled after 3 months and a rubber impression material was used to take impressions utilizing the indirect open tray technique. The final restoration was checked to avoid open margins, open contacts, improper contouring and high spots to provide adequate functioning prosthesis. All of the restorations were made of zirconia, screwed to the implant and tightened with a torque of 30 Ncm in accordance with the manufacturer's instructions. Teflon pellets were then used to cover the access holes for the screws before being sealed with composite. The same dental technician planned and constructed all of the restorations.

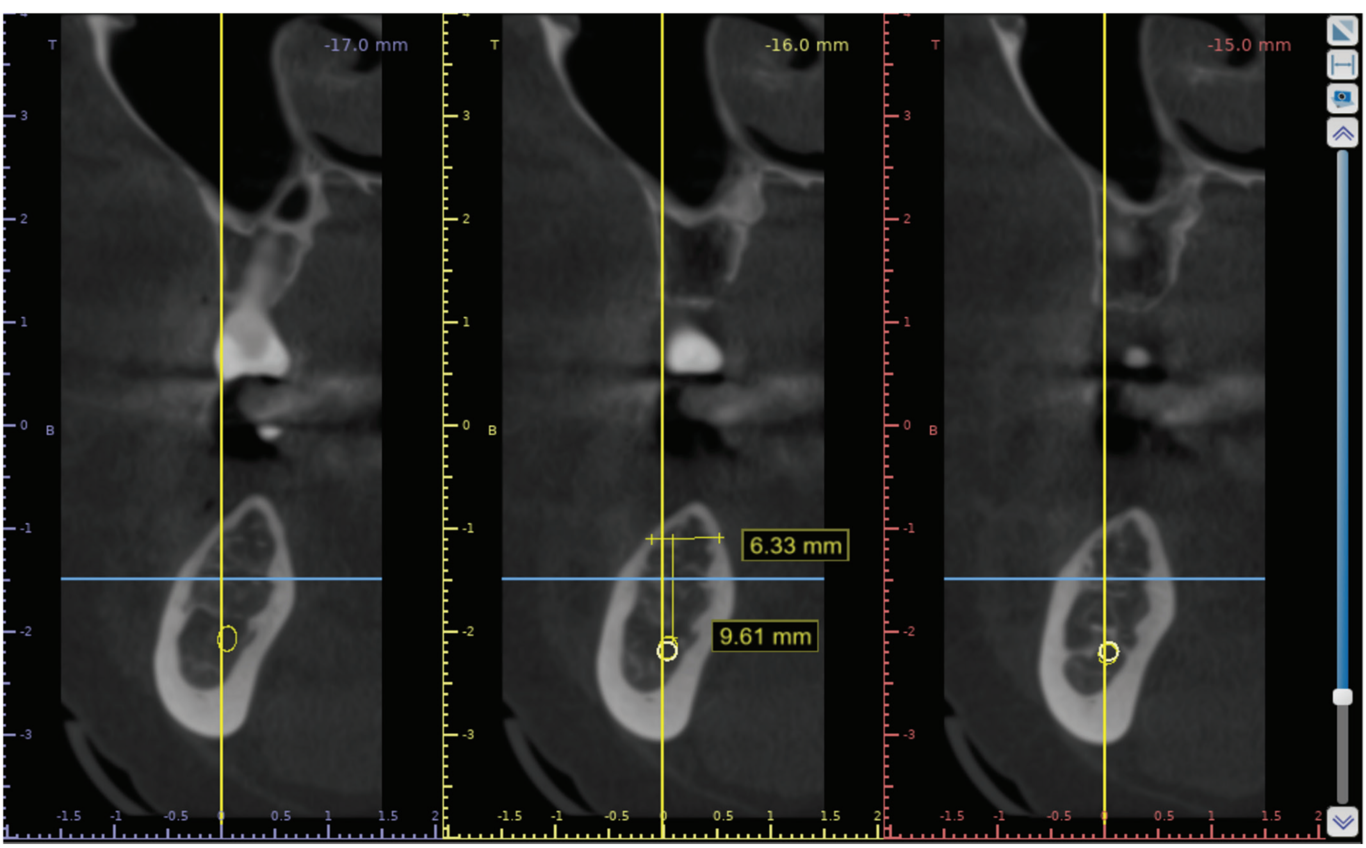

Figure (1) — CBCT preoperative planning for implant placement

Figure (2) — Bone collected during low speed drilling

Radiographic crestal bone level assessment

Long-cone intraoral radiographs were collected under controlled circumstances with personalised X-ray holders (XPC) and a registration bite block for repeatable imaging. The periapical radiographs carried out by digital sensor (Dentsply Sirona - Xios Scan size 2 imaging plate) corresponding to size 2 standardized film and x-ray machine (Vario DG - Model 62 80 262) with fixed parameters. The radiographs in the form of jpg format were successively imported in software Romexis and calibrated to avoid magnification using the already previously known length of each implant before taking the measurements. The neck of the implant was taken as a reference point in all images for standardization.

Three digital periapical radiographs were obtained as follows; 1) Immediately after implant placement during the surgical phase. 2) After 3 months during the loading phase before the placement of the final restoration. 3) 3 months after the delivery of the final restoration (6 months after the implant placement) (Fig.3).

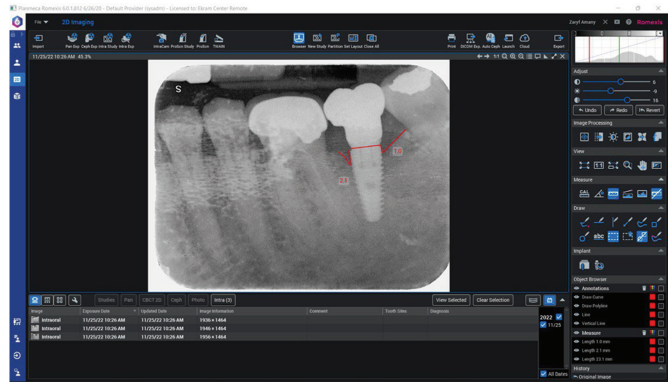

Figure (3) — Measuring the crestal bone loss

Implant stability assessment

Once the implant was properly placed into the osteotomy, with the aid of a resonance frequency analysis device (Osstell® ISQ) (Fig.4), primary stability was measured and recorded in ISQ. During the loading phase, using the same device, the secondary stability was measured.

Statistical analysis

Version 20 of the Statistical Package for Social Sciences (SPSS) was utilized for both data management and statistical evaluation. Using mean, standard deviation, median and range, data were summed up numerically. Data were checked for normalcy by running the Kolmogorov-Smirnov and Shapiro-Wilk tests, along with an analysis of the data distribution. The differences between groups in respect of normally distributed numerical variables were compared using independent t-tests (drilling duration). With regard to non-parametric numerical variables (CBL), Mann Whitney U-test and the Friedman test were employed to compare the two groups. P-values are always two-sided. P-values ≤ 0.05 were considered significant.

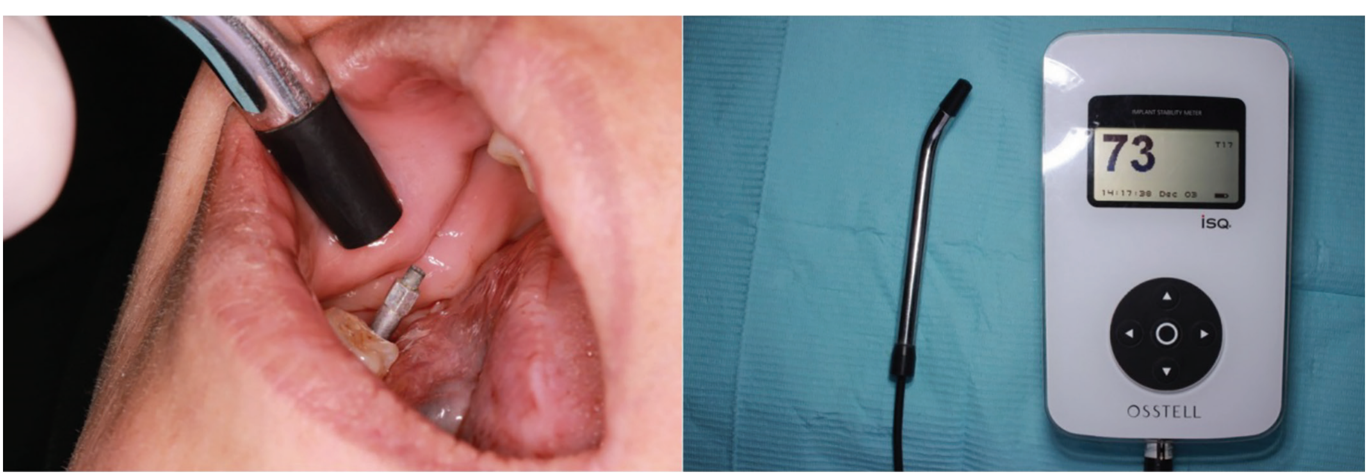

Figure (4) — Osstell device, Osstell transducer and the smartpeg mounted to the implant to measure primary stability

3. RESULTS

Ten patients between the ages of 20 and 40 who satisfied the inclusion criteria were enrolled, eight of them were female and two of whom were male. According to the inclusion criteria, each patient received one or more implants in the mandibular posterior region. There were 20 implants overall, with 10 going to each group. Throughout the healing process, there were no problems at any of the surgery sites.

Crestal bone loss

After 3 months: In the distal side, low speed drilling protocol group recorded a higher median value (0.75) in comparison to conventional drilling protocol group (median =0.6), without a difference between groups that is statistically significant (p=0.364). In the mesial side, low speed drilling protocol group recorded a higher median value (0.8) in comparison to conventional drilling protocol group (median =0.5), without a difference between groups that is statistically significant (p=0.163). Considering both sides together, low speed drilling protocol group recorded a higher median value (0.78) in comparison to conventional drilling protocol group (median =0.55), without a difference between groups that is statistically significant (p=0.161). (Table 1, Fig.5)

After 6 months: In the distal side, low speed drilling protocol group recorded a higher median value (1.15) in comparison to conventional drilling protocol group (median =0.9), without a difference between groups that is statistically significant (p=0.283). In the mesial side, low speed drilling protocol group recorded a higher median value (1.15) in comparison to conventional drilling protocol group (median =0.8), without a difference between groups that is statistically significant (p=0.269). Considering both sides together, low speed drilling protocol group recorded a higher median value (0.115) in comparison to conventional drilling protocol group (median =0.78), without a difference between groups that is statistically significant (p=0.158). (Table 1, Fig.5)

Table (1)

Descriptive statistics of CBL (Mann Whitney U test) comparisons

Time		Distal		Mesial		Mean of distal and mesial	
		Control group	Study group	Control group	Study group	Control group	Study group
3 months	Mean	0.50	0.68	0.53	0.86	0.47	0.77
	Median	0.60[b]	0.75[b]	0.50[b]	0.80[b]	0.55[b]	0.78[b]
	Std. Dev.	0.32	0.53	0.32	0.62	0.32	0.52
	Min	0.00	0.00	0.00	0.00	0.00	0.00
	Max	0.90	1.50	1.10	2.10	0.90	1.55
	P value between groups	.364 ns		.163 ns		.161 ns	
6 months	Mean	0.78	1.03	0.83	1.11	0.73	1.07
	Median	0.90[a]	1.15[a]	0.80[a]	1.15[a]	0.78[a]	1.15[a]
	Std. Dev.	0.37	0.63	0.42	0.57	0.44	0.57
	Min	0.30	0.00	0.10	0.20	0.00	0.20
	Max	1.20	1.90	1.30	2.20	1.25	2.05
	P value between groups	.283 ns		.269 ns		.158 ns	

*Significance level p≤0.05, *significant, ns=non-significant*

Post hoc test: Within the same column, medians having different superscript letters are significantly different

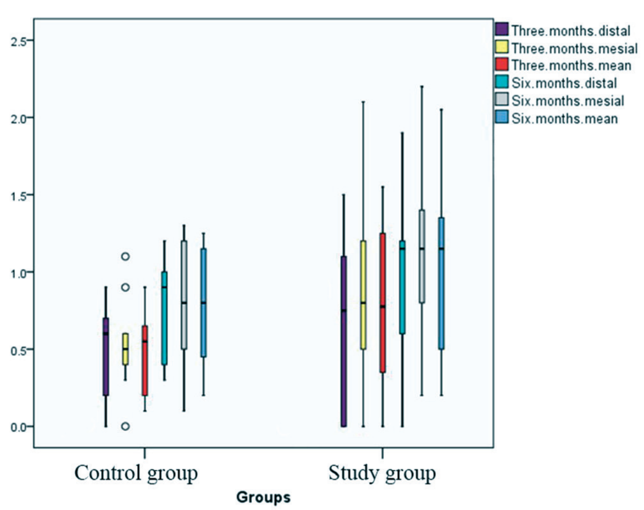

Figure (5) — Box plot illustrating median value and interquartile range of CBL in both groups after 3 and 6 months

Implant stability

Primary stability: Conventional drilling protocol group, stability showed a statistically higher value (74±4.64) in comparison to low speed drilling protocol group (68.7±5.27), (p=0.028), (Table 2, Fig.6)

Secondary stability: Conventional drilling protocol group (66.22±5.47) showed no significant difference from low speed drilling protocol group (68.8±5.51), (p=0.321), (Table 2, Fig.6).

Drilling duration

A significantly higher value (218.8±27.32 seconds)) was recorded using low speed drilling protocol, in comparison to (140.7±19.13seconds) in conventional drilling protocol. The difference between groups was statistically significant (p=0.000).

Table (2)

Descriptive statistics of stability (independent t test) comparisons

Groups		Stability	
		Primary	Secondary
Control group	Mean	74.00	66.22
	Median	74.00	66.00
	Std. Deviation	4.64	5.47
	Range	14.00	15.00
	Minimum	66.00	59.00
	Maximum	80.00	74.00
Study group	Mean	68.70	68.80
	Median	69.50	68.50
	Std. Deviation	5.27	5.51
	Range	16.00	19.00
	Minimum	60.00	58.00
	Maximum	76.00	77.00
Comparison between groups	T	2.39	1.02
	P value	0.028*	0.321 ns

*Significance level p≤0.05, *significant, ns=non-significant*

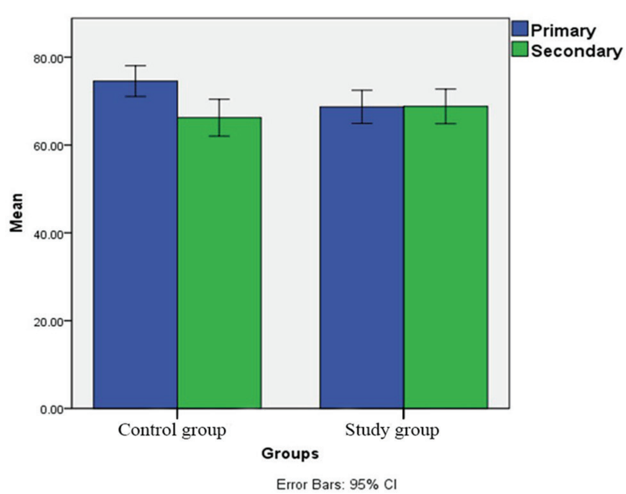

Figure (6) — Bar chart illustrating mean value of primary and secondary stbility in both groups

4. DISCUSSION

Some of the problems of the conventional drilling protocol are the heat generation which is less in the low speed drilling protocol and the abundant irrigation that may impair visualization which is completely absent in the low speed drilling protocol. It seems evident that the heat generation is directly proportional to the drilling speed, thus in order to minimize friction and prevent heat injury when a drilling procedure is employed lacking irrigation, slowing down the drilling speed is necessary[8].

The low speed drilling protocol showed several advantages that were documented mostly in-vitro using measurement systems that cannot be applied in-vivo. This study is an attempt to prove these advantages in-vivo by assessing the CBL surrounding the implants as well as primary and secondary stabilities of the implants. The correlation between implant stability and the low speed drilling protocol has not been examined in an in-vivo study.

Digital periapical radiographs, which are regarded as a trustworthy approach for assessing long-term implant success, were used to evaluate the CBL at three different time points: as soon as the implant has been placed, after 3 months, and after 6 months[15]. To examine the single impact of the used drilling protocol on early bone remodeling, the mean radiography CBL was measured prior to occlusal loading. At 3 and 6 months, there was no statistically significant difference in the CBL between the two groups. These findings were coordinated with findings from other studies[2,8,16].

Success is understood to depend heavily on osseointegration attainment and maintenance in implant dentistry[17]. Primary stability was recorded as soon as the implant has been placed using the Osstell transducer approaching a smart peg in a non-contact form, while the smart peg is mounted to the implant. After 3 months, in the same way, the secondary stability was recorded. The primary stability showed a statistically higher value (74±4.64) in the conventional drilling group in comparison to the low speed drilling group (68.7±5.27). However, there was no statistically significant difference between the conventional drilling group (66.22±5.47) and the low speed drilling group (68.8±5.51) regarding secondary stability. The factors affecting primary stability is different than those affecting secondary stability as primary stability mainly depends on mechanical anchorage while secondary stability depends on bone remodeling. Successful implants typically have ISQ levels between 57 and 82 ISQ[18].

It has been shown that the low speed drilling protocol makes it easier to harvest autogenous bone during drilling without it being contaminated by saliva (Fig.6). The low speed drilling technique can improve vision during drilling and give the operator more accurate information about the drill's path, allowing for any necessary course changes.

5. CONCLUSION

In light of the findings of this study, which are consistent with all prior researches on crestal bone loss, as well as the successful primary and secondary stabilities of the implants whose beds were prepared by the low speed drilling protocol and the fact that the conventional drilling protocol, the gold standard drilling protocol, was used as the control group in this study, we can conclude that the low speed drilling protocol is a successful implant site preparation technique. More research with a bigger sample size and preferably a longer follow-up is advised to confirm its effectiveness.

6. REFERENCES

1. Nóbrega, A. R. et al. Osteotome versus conventional drilling technique for implant site preparation: a comparative study in the rabbit. Int. J. Periodontics Restorative Dent. 32, e109-15 (2012).
2. Calvo-Guirado, J. L. et al. Novel hybrid drilling protocol: evaluation for the implant healing - thermal changes, crestal bone loss, and bone-to-implant contact. Clin. Oral Implants Res. 26, 753–760 (2015).
3. Jimbo, R. et al. Simplified Drilling Technique Does Not Decrease Dental Implant Osseointegration: A Preliminary Report. J. Periodontol. 1–8 (2012) doi:10.1902/jop.2012.120565.
4. Gehrke, S. A. et al. Temperature Changes in Cortical Bone after Implant Site Preparation Using a Single Bur versus Multiple Drilling Steps: An In Vitro Investigation. Clin. Implant Dent. Relat. Res. 17, 700–707 (2015).

5. Vercellotti, T. Technological characteristics and clinical indications of piezoelectric bone surgery. Minerva Stomatol. 53, 207–214 (2004).

6. Ferri, L., Baldoni, M., Bader, A. A. & Caccianiga, P. applied sciences Magnetic Mallet and Laser for a Minimally Invasive. (2022).

7. Anitua, E., Carda, C. & Andia, I. A novel drilling procedure and subsequent bone autograft preparation: a technical note. Int. J. Oral Maxillofac. Implants 22, 138–45 (2007).

8. Pellicer-Chover, H. et al. Comparison of peri-implant bone loss between conventional drilling with irrigation versus low-speed drilling without irrigation. Med. Oral Patol. Oral Cir. Bucal 22, e730–e736 (2017).

9. José, L. F. de S. et al. Influence of drilling technique on the radiographic, thermographic, and geomorphometric effects of dental implant drills and osteotomy site preparations. J. Clin. Med. 9, 1–11 (2020).

10. Oh, J.-H., Fang, Y., Jeong, S.-M. & Choi, B.-H. The effect of low-speed drilling without irrigation on heat generation: an experimental study. J. Korean Assoc. Oral Maxillofac. Surg. 42, 9 (2016).

11. Park, J. C. et al. Acquisition of human alveolar bone-derived stromal cells using minimally irrigated implant osteotomy: In vitro and in vivo evaluations. J. Clin. Periodontol. 39, 495–505 (2012).

12. Eriksson, R. A. & Albrektsson, T. The effect of heat on bone regeneration: an experimental study in the rabbit using the bone growth chamber. J. oral Maxillofac. Surg. Off. J. Am. Assoc. Oral Maxillofac. Surg. 42, 705–711 (1984).

13. Li, W. T., Li, P., Piao, M. Z., Zhang, F. & DI, J. Study on bone volume harvested from the implant sites with different methods. Beijing Da Xue Xue Bao. 52, 103–106 (2020).

14. Gaspar, J., Borrecho, G., Oliveira, P., Salvado, F. & Martins dos Santos, J. Osteotomy at low-speed drilling without irrigation versus high-speed drilling with irrigation: an experimental study. Acta Med. Port. 26, 231–6 (2013).

15. Albrektsson, T., Buser, D. & Sennerby, L. Crestal Bone Loss and Oral Implants. Clin. Implant Dent. Relat. Res. 14, 783–791 (2012).

16. Tabassum, A. Radiographic comparisons of crestal bone levels around implants placed with low-speed drilling and standard drilling protocols: Preliminary results. Saudi Dent. J. (2021) doi:10.1016/j.sdentj.2021.08.003.

17. Galindo-Moreno, P. et al. Marginal bone loss around implants placed in maxillary native bone or grafted sinuses: A retrospective cohort study. Clin. Oral Implants Res. 25, 378–384 (2014).

18. Sachdeva, A., Dhawan, P. & Sindwani, S. Assessment of Implant Stability: Methods and Recent Advances. Br. J. Med. Med. Res. 12, 1–10 (2016).