

Osteotomy Protocol for Implant Insertion of One Day Biotech: One Drill, One Implant

Jin Hwan Kim¹, Jaehyun Song¹ , Jaegyun Choi¹, Jose Francisco Ballester² , Ireh Kim³, Santiago Jose Ballester²

¹Private Practice, Seoul, South Korea

²Private Practice, Valencia, Spain

³Seul, South Korea

Email: Jimbol2002@hotmail.com, efil1227@gmail.com, ireh020509@gmail.com, jfballester@me.com, skswhd125@naver.com, sanbalbo@gmail.com

How to cite this paper: Kim, J.H., Song, J., Choi, J., Ballester, J.F., Kim, I. and Ballester, S.J. (2024) Osteotomy Protocol for Implant Insertion of One Day Biotech: One Drill, One Implant. *Open Journal of Stomatology*, 14, 255-277.

<https://doi.org/10.4236/ojst.2024.145021>

Received: February 27, 2024

Accepted: May 28, 2024

Published: May 31, 2024

Copyright © 2024 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Background: Four factors determine the quality of an implantology kit: 1) Heat generated by the drills; 2) Morphology of the osteotomy according to the diameter of the implant; 3) Efficiency of collecting autologous bone; and 4) Osteotomy execution time. **Materials and Methods:** This article examines the heat produced by drills during osteotomy, focusing on the effect of the following factors: drilling technique; volume of autologous bone harvested; drilling time; implant primary stability; and the percentage of osseointegrated implants after primary healing. **Discussion:** The four factors mentioned above are analyzed based on the data obtained for sequential, biological, and One Drill milling techniques. **Conclusions:** 1) One Drill is the fastest technique for performing the osteotomy; 2) All techniques stay within the biological temperature range of living bone, with the lowest increase in temperature achieved using One Drill with irrigation; 3) The bone harvested showed no statistically significant differences between biological milling and the One Drill technique, both far superior to the sequential technique; and 4) There is no statistically significant difference in the number of osseointegrated implants among the three techniques analyzed.

Keywords

Dental Implant, Bur, Primary Stability, Drilling Time, Osteotomy, Irrigation, Bone Collected

1. Introduction

Since the development of the concept of osseointegration [1], bone osteotomy

for implant insertion has aimed at controlling the main factors leading to osseointegration failure. The improvements include avoiding infection, calibrating the osteotomy with respect to the implant diameter, and keeping the protein below denaturation temperature during the surgical act [2] [3].

With respect to the first point, avoiding infection, Prof. I Brånemark [4] remarked that implant surgery is an orthopedic surgery and must follow the same principles: asepsis of the room (disinfection of the surfaces of the environment), of the surgeon (hands, clothing, sterile field), of the material (micromotor, contra-angle handpiece, surgical kit, implant kit) and of the patient (mouth, anesthesia).

The second point, or “osteotomy calibration,” has undergone an important change from its beginnings to the present day. Nowadays, surgeons have adopted the “self-tapping” technique: implants do not need tapping, and the threads do not need to penetrate the bone. These features result in greater primary stability and shorter working time (**Figure 1**).

The third point, “keeping the protein below the protein denaturation temperature,” or equivalently, “maintaining bone temperature at physiological levels,” has undergone the greatest evolution [5] [6] [7]. This development can be divided into maintaining suitable temperatures in soft and hard tissue, respectively.

With respect to soft tissue, the surgical procedure must be atraumatic, aseptic, and ensure perfect coagulation and hermetic suture.

There is greater controversy with respect to conditions of the hard tissue, even though all techniques aim to follow the second point. Here is the reasoning: if hard tissue temperature exceeds 47°C for 30 seconds or 40°C for 7 minutes [8], or 55° bone necrosis will occur [9] [10]. Denaturation of alkaline phosphatase takes place at 56°C.

There are three basic milling techniques; 1) Sequential milling, derived from the Brånemark protocol (1969); 2) Low speed milling, known as biological milling; and 3) Milling with a single bur.

The initial phase is common to all three procedures:

pilot drill, between 0.8 and 1.2 mm in diameter, at 800 to 1500 rpm in speed.

In the second phase, widening, each technique differs in its approach to avoid overheating of the bone [11].

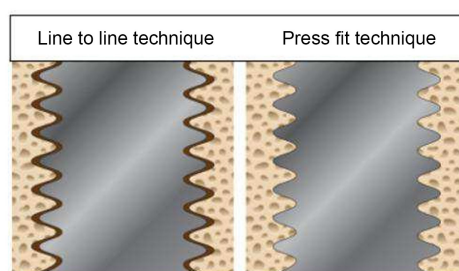


Figure 1. Non-self-tapping and self-tapping implants.

In the protocols derived from Brånemark [12] [13], sequential drilling always relies on the use of refrigerated saline solution, at speeds between 800 and 1300 rpm [14] [15] with external or internal irrigation drills [16].

In the biological drilling procedure, the increase in temperature is controlled by decreasing drilling speed (50 rpm) and increasing the attack force (50 - 80 Nw) without the use of physiological saline solution. In particular, Mathews [17] remarked that without irrigation, the temperature increases. Sarendranath [18] made the same remark several years later.

The single bur drilling technique, a variant of the Brånemark technique, avoids all intermediate steps thanks to the bur's macromorphology. This approach does not increase temperature, thus reducing the risk of infection and bone necrosis, and improves the macromorphology of the implant osteotomy [19] [20].

The quality of the bone, including cortical thickness and cancellous density, will influence all three techniques [21] [22] [23] [24].

The most classic classifications of bone are: Lekholm U_Zarb GA (Figure 2) and Misch C (Figure 3).

With this background information in mind, the main objective of this article is to determine the heat generated during osteotomy by the three bone milling techniques. Secondary objectives include describing the surgical protocol of One day Biotech (One Drill-One implant), assessing the concordance of implant bed osteotomy morphology with implant diameter, measuring the volume of autologous bone harvested during osteotomy for an implant, and determining the percentage of osteo-integrated implants at eight weeks according to the technique used.

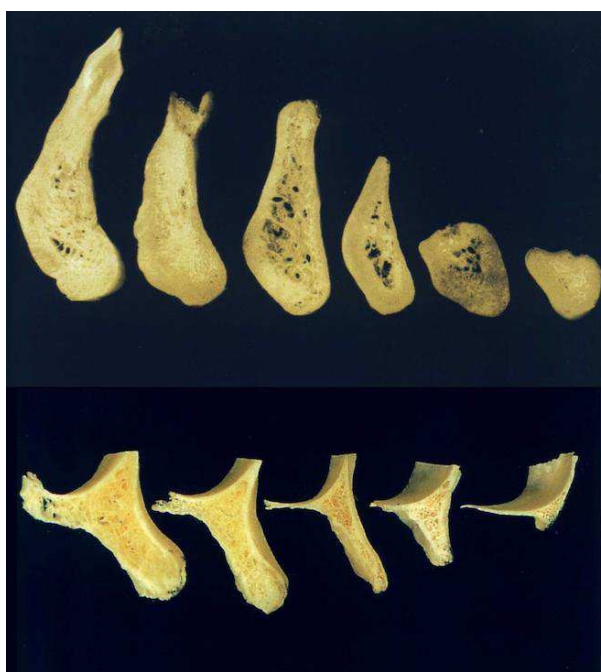


Figure 2. Lekholm-Zarb classification.

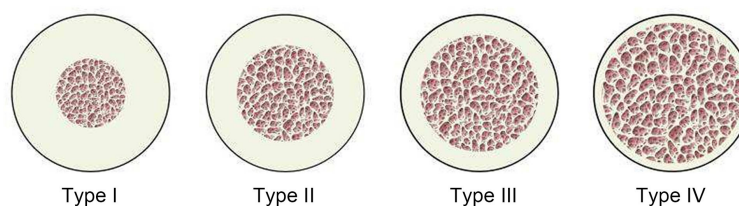


Figure 3. Misch's classification of bone densities.

2. Materials and Methods

The study was conducted by measuring outcomes in 90 cases, divided into three groups of 30 cases each.

The materials used in the experimental phase were Plexiglas sheets and pine wood. The materials used in the clinical phase were: TSK surgical kit by Phibo: One Drill kit by One Day Biotech and Bis by Biotech Dental. The implant used was always 4.5 mm in diameter and 10 mm in length.

Torque was measured with a torque wrench, AFR with the Osstel ISQ, time with a stopwatch and osteointegration at eight weeks was determined as Yes or No.

The data obtained were processed using the SPSS 23 program, with a confidence level of 95%, considered statistically significant when $P < 0.05$. If the p-value is less than 0.05, then we reject the null hypothesis. The Saphiro-Wilk test was used as a normality test.

The criteria for selecting test subjects were as follows:

Inclusion Criteria:

- Adult patients over 18 years of age;
- Patients requiring implant treatment and possessing sufficient bone, thus eliminating the need for GTR or complementary surgical techniques;
- Patients agreeing to sign the informed consent form and committing to attending check-up appointments.

Exclusion Criteria:

- Patients with endocrine-metabolic diseases;
- Patients with acute or chronic infectious diseases;
- Patients with a history of taking bisphosphonates;
- Patients with a history of smoking;
- Patients with post-extraction sockets;
- Patients with immediate implants.

2.1. Experimental Phase

All procedures indicate use of milling drill for implants of 4.5 mm in diameter and 10 mm in depth.

2.1.1. Temperature Reached

Performed using passive thermography according to UNL-EN 16/14-I: 2017, measuring the apparent temperature, with no use of compensation parameters of the thermal detector (**Table 1**).

Table 1. Heat generated during osteotomy with drills. S: sequential drilling; B: biological drilling; OD: one drill, drilling with and without irrigation. (a) Statistical data on heat generated during osteotomy. (b) Analysis of variance of heat generated during osteotomy with irrigation. (c) Analysis of variance of heat generated during osteotomy without irrigation.

tec	FS		F Bio		Fresa One Drill	
	Con	Sin	Con	Sin	Con	Sin
1	37.3	63		41.9	28.8	50.9
2	37.1	63.1		41.9	29	50.9
3	37.2	62.9		41.4	28.3	50.8
4	37.2	62.8		41.5	29.1	50.8
5	36.9	62.8		41.7	28.5	50.8
6	36.8	62.9		41.7	28.6	50.1
7	36.9	62.9		41.8	28.6	50.2
8	36.7	62.9		41.8	28.2	50.2
9	36.7	63.1		41.8	29.2	50.2
10	36.7	63.1		41.3	29.1	49.9
11	37.1	63.1		41.3	29.3	49.9
12	37.1	63.1		41.4	29.1	49.9
13	37.3	63.2		41.4	28.7	49.9
14	37.4	63.3		42.1	28.5	50.7
15	37.4	63.1		42.1	28.6	50.1
16	37.5	63.3		42.2	28.6	50.2
17	37.1	63.3		41.2	28.8	50.2
18	37.2	63.5		39.9	28.7	49.8
19	37.1	62.9		41.7	28.1	50.1
20	37.5	62.9		41.7	29.4	50.2
21	37.4	63.1		41.6	29.1	50.2
22	37.4	62.8		41.6	28.9	50.2
23	36.8	62.8		41.6	28.9	50.1
24	36.9	63.3		41.7	29.3	49.9
25	36.9	62.8		41.7	29.1	49.8
26	37.6	62.9		40.9	29.5	49.8
27	37.4	62.9		40.8	29.3	49.7
28	37.6	62.9		40.8	28.9	50.3
29	37.6	63.4		41.2	28.7	50
30	36.9	63.5		41.7	28.6	50.1

Continued

(a)						
	FS			FB		FO
Media	37.16	63.05		41.51	28.85	50.20
Mediana	37.15	63.05		41.65	28.85	50.15
Moda	37.1	62.9		41.7	29.1	50.2
Desviación Típica	0.2873	0.2145		0.4659	0.3579	0.3518
Varianza	0.0825	0.0460		0.2171	0.1281	0.1238

(b)						
<i>Origen de las variaciones</i>	<i>Suma de cuadrados</i>	<i>Grados de libertad</i>	<i>Promedio de los cuadrados</i>	<i>F</i>	<i>Probabilidad</i>	<i>Valor crítico para F</i>
Entre grupos	1035.010667	1	1035.010667	9827.122995	2.01614E-66	4.006872886
Dentro de los grupos	6.108666667	58	0.105321839			
Total	1041.119333	59				

(c)						
<i>Origen de las variaciones</i>	<i>Suma de cuadrados</i>	<i>Grados de libertad</i>	<i>Promedio de los cuadrados</i>	<i>F</i>	<i>Probabilidad</i>	<i>Valor crítico para F</i>
Entre grupos	7046.657556	2	3523.328778	27322.36417	1.8017E-122	3.101295757
Dentro de los grupos	11.219	87	0.128954023			
Total	7057.876556	89				

The P-value of the ANOVA test is 2.02E-66, which is less than 0.05. Therefore, we can affirm that there is a relationship between different types of drilling with irrigation and heat generated during osteotomy, while the One Drill temperature is lower than the sequential milling by an average of 9.13 degrees (Table 1(a), Table 1(b)).

The P-value of the ANOVA test is 1.80E-122, which is less than 0.05, therefore we can affirm that there is a relationship between the different types of drilling without irrigation and heat generated during osteotomy, with the FB obtaining the lowest increase in temperature with respect to the One Drill milling cutters, by an average of 8.69 degrees (Table 1(c), Figure 4).

2.1.2. Osteotomy Morphology

Performed with the use of pine wood sticks.

We define “Hardness” as the resistance to tool penetration, using the Brinell scale. Pine wood with a Brinell hardness of 1.6 Class A and a thickness of 12 mm was chosen.

Osteotomy morphology was measured indirectly by comparing it to the reamer diameter (Table 2).

The P-value of the ANOVA test is 4.85E-06, which is less than 0.05. Therefore, we can affirm that there is a relationship between the different types of drilling and the morphology of the cervical osteotomy, with the One Drill producing the best result (Table 2(a), Table 2(b)).

Table 2. Difference between the diameter of the osteotomy and the diameter of the drill, coronal and apical. (a) Statistical data of the difference between osteotomy diameter and reamer diameter at the cervical and apical levels. (b) Analysis of variance of the difference between osteotomy and reamer diameter at coronal level. (c) Analysis of variance of the difference between the diameter of the osteotomy and the diameter of the reamer at the apical level.

pcnt/tec	FS		F BIO		FRESA ONE DRILL	
	Dif. Cervical	Dif. Apical	Dif. Cervical	Dif. Apical	Dif. Cervical	Dif. Apical
1	0.1	0	0.2	0.1	0.1	0.1
2	0	0	0.2	0.2	0.1	0
3	0.2	0	0.3	0.1	0.2	0
4	0.2	0.3	0.4	0.1	0.1	0
5	0.2	0.1	0.3	0.1	0.1	0.1
6	0.1	0.1	0.2	0.2	0.2	0
7	0.3	0.2	0.4	0.3	0.1	0
8	0.2	0.2	0.3	0.2	0.1	0.2
9	0.2	0.3	0.3	0.3	0.2	0.2
10	0.2	0.1	0.4	0.3	0.2	0.2
11	0.1	0.1	0.2	0.4	0.2	0
12	0.2	0.1	0.1	0.1	0.3	0
13	0.3	0.1	0.1	0.1	0.1	0.1
14	0.2	0.4	0.2	0.1	0.1	0.3
15	0.2	0.3	0.4	0.1	0.1	0.2
16	0.2	0.4	0.3	0.2	0.1	0.2
17	0.2	0.4	0.4	0.3	0.2	0.1
18	0.1	0	0.4	0.3	0.2	0.1
19	0	0.1	0.3	0.1	0.1	0.1
20	0.1	0.2	0.2	0.1	0.2	0
21	0.2	0.2	0.3	0.1	0.3	0
22	0.3	0.2	0.3	0.1	0.2	0.1
23	0.3	0.3	0.4	0.2	0.1	0.2
24	0.1	0.1	0.3	0.2	0.1	0.2
25	0.4	0.1	0.4	0.3	0.1	0.1
26	0.1	0	0.2	0.1	0.2	0.1
27	0	0	0.2	0.2	0.1	0.1
28	0	0.4	0.1	0.1	0.2	0
29	0.2	0.3	0.1	0.1	0.2	0
30	0.4	0.3	0.3	0.2	0.2	0

Continued

(a)						
	FS		F BIO		FRESA ONE DRILL	
	Dif. Cervical	Dif. Apical	Dif. Cervical	Dif. Apical	Dif. Cervical	Dif. Apical
Media	0.20	0.22	0.27	0.18	0.16	0.15
Mediana	0.2	0.2	0.3	0.15	0.15	0.1
Moda	0.2	0.1	0.3	0.1	0.1	0.1
Desviación Típica	0.0871	0.1141	0.1015	0.0898	0.0626	0.0618
Varianza	0.0076	0.0130	0.0103	0.0081	0.0039	0.0038

(b)						
<i>Origen de las variaciones</i>	<i>Suma de cuadrados</i>	<i>Grados de libertad</i>	<i>Promedio de los cuadrados</i>	<i>F</i>	<i>Probabilidad</i>	<i>Valor crítico para F</i>
Entre grupos	0.206423375	2	0.103211688	14.23139515	4.8512E-06	3.106507082
Dentro de los grupos	0.601948718	83	0.007252394			
Total	0.808372093	85				

(c)						
<i>Origen de las variaciones</i>	<i>Suma de cuadrados</i>	<i>Grados de libertad</i>	<i>Promedio de los cuadrados</i>	<i>F</i>	<i>Probabilidad</i>	<i>Valor crítico para F</i>
Entre grupos	0.054944444	2	0.027472222	3.168547151	0.048248938	3.129643983
Dentro de los grupos	0.59825	69	0.00867029			
Total	0.653194444	71				

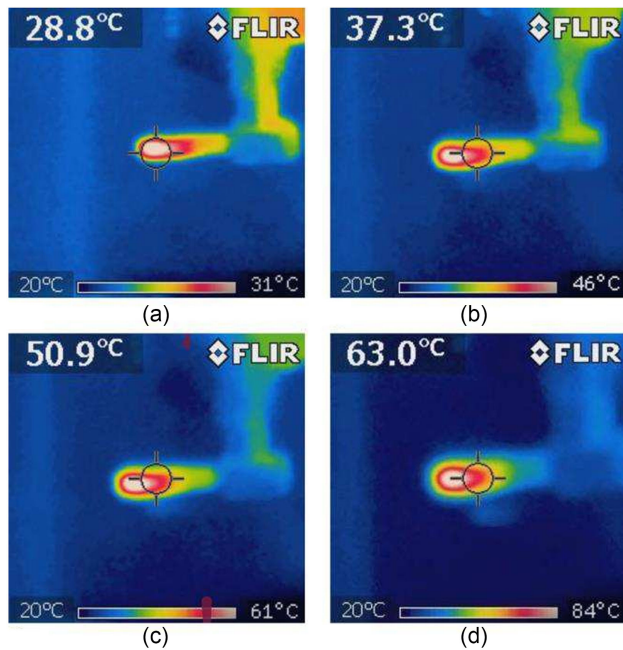


Figure 4. (a) Thermography of the One Drill with irrigation. (b) Thermography with sequential drilling and irrigation. (c) Biological drilling without irrigation. (d) Sequential drilling without irrigation.

The P-value of the ANOVA test is 0.048, which is less than 0.05. Therefore, we can affirm that there is a relationship between the different types of apical osteotomy morphology and the type of drill used, with the One Drill drills producing the best data (Table 2(c)).

2.2. Clinical Phase

2.2.1. Surgical Protocol of the One Day Biotech One Drill Kit

The surgical protocol varies depending on the type of bone.

The standard protocol is used on Type II bone (Figure 5). Begin by marking the cortex using the guide drill, which serves as a pilot drill, at 1200 rpm. Proceed directly with the final One Drill, ensuring its diameter matches that of the selected implant. The length is determined by the Stopper. The numbers 3.8, 4.0, 4.5, 5.0 represent the implant diameters. The drill is consistently under-dimensioned by 0.4 mm.

In Type III bone, the guide drill is not necessary.

In Type IV bone, we directly use the One Drill with a diameter smaller than that of the implant.

In Type I bone, the Guide Drill is used, followed by the Lindeman 2 mm drill, the One Drill of the corresponding diameter, and finally the Counter Sink drill. In the case of very dense bone, the One Drill is followed by the Twist Drill (Figure 6).

Once the osteotomy is completed, we unscrew the active part of the handle and remove the autologous bone using the stem of the Bone Pusher (Figure 7).

Summary of milling frequency according to bone type

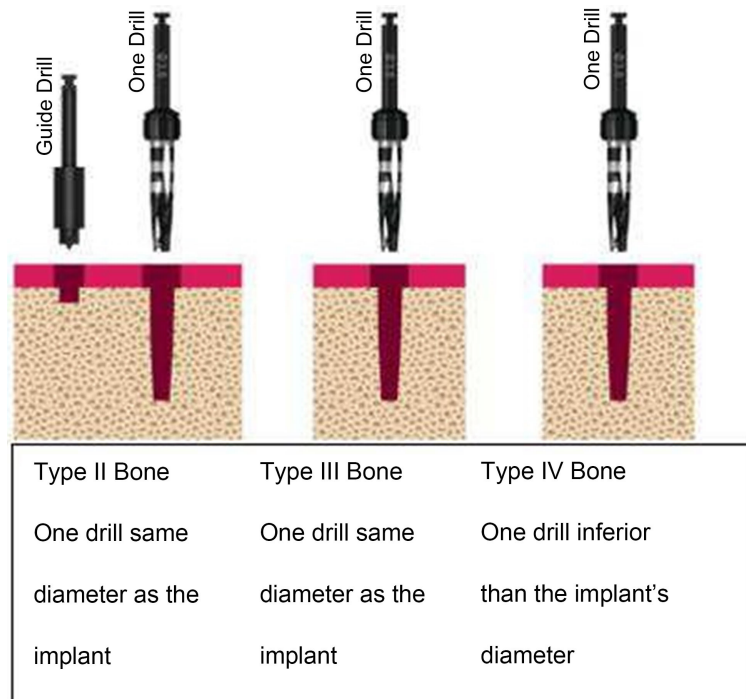


Figure 5. One drill implant drilling protocol for type II, III and IV bones.

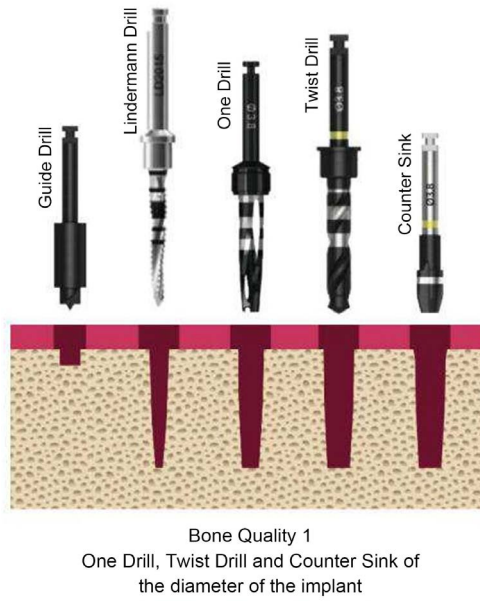


Figure 6. One Drill implant drilling protocol for Type I bone.



Figure 7. Bone recovery from the One Drill.

Bone Type	Guide	Lindemand	One Drill	One Drill 1 dia. Inf. to the dia. of the implant	Twist Drill	Counter Sink
I	X	X	X		X	X
II	X		X			
III			X			
IV				X		

2.2.2. Volume of Autologous Bone Harvested with the Drilling of the Osteotomy for an Implant of 4.5 mm in Diameter and 10 mm in Length, Measured in Cubic Centimeters (Table 3)

The P-value of the ANOVA test is 6.83E-26, which is less than 0.05. Therefore,

we can affirm that there is a relationship between the different types of milling and the bone collected. The FB milling cutter is the one that collects most bones, followed by the One Drill milling cutter (**Table 3(a)**, **Table 3(b)**).

Table 3. Volume of autologous bone, depending on the type of drilling. (a) Statistical data on autologous bone volume. (b) Analysis of variance of autologous bone volume.

pcnt/tec	FS	F BIO	FRESA ONE DRILL
1	0.02	0.11	0.07
2	0.03	0.10	0.07
3	0.05	0.04	0.08
4	0.01	0.09	0.09
5	0.02	0.07	0.06
6	0.03	0.13	0.07
7	0.02	0.12	0.06
8	0.02	0.12	0.06
9	0.01	0.12	0.07
10	0.01	0.07	0.07
11	0.01	0.06	0.08
12	0.03	0.07	0.08
13	0.04	0.08	0.08
14	0.04	0.09	0.06
15	0.05	0.09	0.07
16	0.05	0.11	0.06
17	0.05	0.12	0.06
18	0.03	0.12	0.09
19	0.03	0.12	0.04
20	0.04	0.07	0.08
21	0.01	0.07	0.08
22	0.02	0.07	0.06
23	0.02	0.11	0.06
24	0.02	0.10	0.06
25	0.01	0.10	0.05
26	0.04	0.10	0.07
27	0.04	0.11	0.09
28	0.03	0.08	0.06
29	0.03	0.09	0.05
30	0.03	0.10	0.07

Continued

(a)						
	FS		FB		F One Drill	
Media	0.03		0.09		0.07	
Mediana	0.03		0.1		0.07	
Moda	0.03		0.07		0.06	
Desviación Típica	0.0132		0.0224		0.0123	
Varianza	0.0002		0.0005		0.0002	

(b)						
Origen de las variaciones	Suma de cuadrados	Grados de libertad	Promedio de los cuadrados	F	Probabilidad	Valor crítico para F
Entre grupos	0.067028889	2	0.033514444	121.3213592	6.82646E-26	3.101295757
Dentro de los grupos	0.024033333	87	0.000276245			
Total	0.091062222	89				

2.2.3. Percentage of Osseointegrated Implants Eight Weeks after Insertion

Success or failure of osseointegration was determined at 12 weeks, according to the criteria of Albrektsson [25] (Table 4).

When comparing both the FS and F One Drill techniques, as well as the FBio and F One Drill techniques, the P-value of the null hypothesis exceeds 0.05. Therefore, we accept the hypothesis that osseointegration is independent of the drilling technique (Table 4(a)).

2.2.4. Duration of Osteotomy and Primary Stability of the Implant

We measured the following indirectly: Osteotomy duration and primary implant stability, and insertion torque and frequency analysis (RFA).

The time was measured from the beginning of the osteotomy to its completion with a stopwatch. Insertion torque was measured with the torque wrench (Ti). Resonance frequency analysis (RFA) was measured with the Osstel ISQ (Table 5).

The P-value of the ANOVA test is 0.81, which is greater than 0.05, so we can affirm that there is no relationship between the torque achieved and the milling system used (Table 5(a), Table 5(b)).

The P-value of the ANOVA test is 0.72, which is greater than 0.05. Therefore, we can affirm that there is no relationship between the ISQ of the different types of milling (Table 5(c)).

The P-value of the ANOVA test is 2.22E-59, which is less than 0.05. Therefore, we can affirm that there is a relationship between the different types of milling and the milling time. Milling with One Drill is the fastest with an average of 6.4 seconds (Table 5(d)).

Table 4. Osseointegrated implants at 12 weeks. (a) Chi-square test for FS-FOne Drill and FBio-F One Drill osseointegration variable pairs.

Número de caso	FS	FBio	F One Drill
1	NO	NO	Sí
2	Sí	Sí	Sí
3	Sí	Sí	Sí
4	Sí	Sí	Sí
5	Sí	Sí	Sí
6	Sí	Sí	Sí
7	Sí	Sí	Sí
8	Sí	Sí	Sí
9	Sí	Sí	Sí
10	Sí	Sí	Sí
11	Sí	Sí	Sí
12	Sí	Sí	Sí
13	Sí	Sí	Sí
14	Sí	Sí	Sí
15	Sí	Sí	Sí
16	Sí	Sí	Sí
17	Sí	Sí	Sí
18	Sí	Sí	Sí
19	Sí	Sí	Sí
20	Sí	Sí	Sí
21	Sí	Sí	Sí
22	Sí	NO	Sí
23	Sí	Sí	Sí
24	Sí	Sí	Sí
25	Sí	Sí	Sí
26	Sí	Sí	Sí
27	Sí	Sí	Sí
28	Sí	Sí	Sí
29	Sí	Sí	Sí
30	Sí	Sí	Sí

(a)

	Observado			Esperado			P value
	Sí	No		Sí	No		
FS	29	1	30	FS	29.5	0.5	0.313244
Fone Drill	30	0	30	Fone Drill	29.5	0.5	
	59	1	60				
FBio	28	2	30	FS	29	1	0.150323
Fone Drill	30	0	30	Fone Drill	29	1	
	58	2	60				

Table 5. Drilling time, torque force for implant insertion and resonant frequency analysis (ISQ). (a) Statistical data of milling time, torque force and resonance frequency analysis. (b) Torque force analysis. (c) Analysis of variance of the ISQ. (d) Analysis of variance of osteotomy milling time.

pcnt/tec	FS			F BIO			FRESA ONE DRILL		
	Tiempo	Torque	ISQ	Tiempo	Torque	ISQ	Tiempo	Torque	ISQ
1	55.57	35	63	120	34	62	6.81	35	65
2	53.03	36	57	70.9	39	69	7	38	68
3	54.01	31	61	130	31	68	5.9	39	69
4	54.0	40	62	145	38	69	6.70	39	73
5	55.0	41	63	145.3	38	65	13.97	38	72
6	55.6	42	60	90.8	38	68	4.66	38	71
7	54.3	38	69	100.7	40	71	5.30	39	78
8	54.2	37	70	100.8	40	79	7.3	36	73
9	54.5	37	78	120.3	41	77	7.7	37	74
10		35	77		42	73		36	67
11	50.3	35	71	123	37	69	7	35	68
12	50.7	36	69	121.7	36	73	6	35	69
13	51.7	35	68	107	36	75	6.3	35	69
14	52.3	40	68	108	37	78	5.9	40	80
15	54.7	41	69	121	41	81	6.2	41	78
16	54.8	40	79	90.9	40	63	6.5	42	77
17	51.3	40	78	99	40	71	5.5	40	78
18	55.0	39	77	99.3	40	69	4.70	39	76
19	49.8	38	79	113.7	42	78	5.30	39	68
20	50.3	31	68	120.5	35	67	4.80	35	71
21	51.2	35	69	131.3	36	69	4.86	35	63
22	50.8	34	67	119.3	35	72	5.4	36	72
23	55.6	34	71	118	35	78	5.1	35	67
24	54.8	41	79	118.7	34	73	7.2	34	65
25	54.3	38	76	121.3	40	79	8.3	35	80
26	50.7	37	75	123.2	39	78	6.1	37	71
27	50.8	39	74	119.7	38	69	7.1	39	67
28	49.7	39	73	121.1	37	71	8	35	68
29	55.0	40	69	122	37	64	5.2	40	67
30	55.6	40	73	108.7	35	67	4.9	36	70

Continued

(a)									
	FS			FBio			F One Drill		
	Tiempo	Torque	ISQ/AFR	Tiempo	Torque	ISQ/AFR	Tiempo	Torque	ISQ/AFR
Media	53.09	37.47	70.40	114.86	37.70	71.50	6.40	37.27	71.13
Mediana	54.01	38	69.5	119.7	38	71	6.1	37	70.5
Moda	55	40	69	#N/D	40	69	7	35	68
Desviación Típica	2.0821	2.9212	6.1566	15.7742	2.6672	5.2044	1.7863	2.2118	4.6885
Varianza	4.1858	8.5333	37.9034	240.2476	7.1138	27.0862	3.0810	4.8920	21.9816

(b)							
ANÁLISIS DE VARIANZA F TORQUE							
<i>Origen de las variaciones</i>	<i>Suma de cuadrados</i>	<i>Grados de libertad</i>	<i>Promedio de los cuadrados</i>	<i>F</i>	<i>Probabilidad</i>	<i>Valor crítico para F</i>	
Entre grupos	2.822222222	2	1.411111111	0.206111142	0.814138824	3.101295757	
Dentro de los grupos	595.6333333	87	6.846360153				
Total	598.4555556	89					

(c)							
ANÁLISIS DE VARIANZA AFR							
<i>Origen de las variaciones</i>	<i>Suma de cuadrados</i>	<i>Grados de libertad</i>	<i>Promedio de los cuadrados</i>	<i>F</i>	<i>Probabilidad</i>	<i>Valor crítico para F</i>	
Entre grupos	18.82222222	2	9.411111111	0.324628296	0.72366769	3.101295757	
Dentro de los grupos	2522.166667	87	28.99042146				
Total	2540.988889	89					

(d)							
ANÁLISIS DE VARIANZA Tiempo de fresado							
<i>Origen de las variaciones</i>	<i>Suma de cuadrados</i>	<i>Grados de libertad</i>	<i>Promedio de los cuadrados</i>	<i>F</i>	<i>Probabilidad</i>	<i>Valor crítico para F</i>	
Entre grupos	171690.084	2	85845.0418	1004.60559	2.2161E-59	3.10515661	
Dentro de los grupos	7177.92492	84	85.4514872				
Total	178868.008	86					

3. Discussion

In our study, heat generated is directly related to drilling technique, material used, bone quality and osteotomy depths, in a manner similar to Eriksson [26].

Heat is generated in three zones (**Figure 8**): the first or shear zone (bone/chip); the secondary (tool/chip); and the tertiary (tool/bone), which directly relates to the wear of the bur (frictional heat). In total, 98% of the consumed energy is transformed into heat [27].

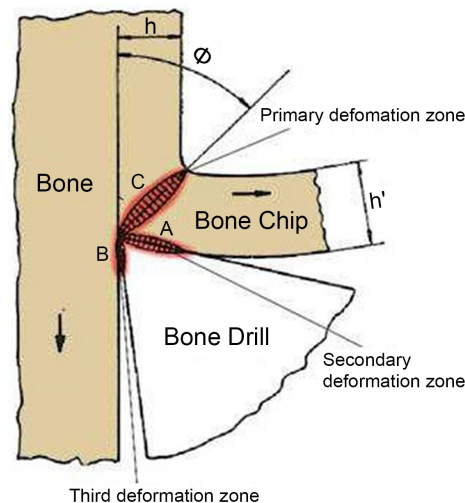


Figure 8. Cutting zones where heat is generated.

Most systems offer similar speeds: pilot milling cutter at 800 rpm; helical milling cutters at 1200 rpm; and tap milling cutter at 50 rpm [28] [29] [30]. The only method that differs is low-speed milling or biological milling, at the cost of increasing cutting force [31].

The formula below indicates that heat equals shear force, which is expressed in Nw. per shear rate:

$$Q = F_t \times V_c$$

Q is heat.

F_t shear force in Nw V_c speed in rpm.

The heat generated is the same for all three techniques if we keep the V_c speed proportional to the cutting force.

The single drill technique, a variation of the Brånemark technique, utilizes a drill with macromorphology to bypass intermediate steps, thereby reducing infection risk and improving the micromorphology of the implant osteotomy.

Biological milling (50 rpm without irrigation) takes more time, increases the risk of infection and results in no temperature difference.

All three techniques are influenced equally by bone quality (cortical thickness, cancellous hardness and osteotomy depth).

In 1993, Bert found that temperature depends on cooling, intermittent milling, and rotation speed [32], data which are supported by our study. Biological milling requires a cutting force greater than 50 Nw [33]. Therefore, the heat generated will be equal to 50 times 50, which is 2500 rpm. The heat generated is equivalent to that of sequential milling.

Tamburi discovered that cutting edge loss occurs after 20 uses, increasing friction and temperature [34]. The One Drill, which is coated with TRIMRITE steel, can be used at least 100 times before showing wear.

A bur must detail the cutting zone's morphology (helical, straight, cross), attack angle, usage count, diameter, speed, and irrigation type for effective comparison.

The helical cutting zone is the most frequent (Brånemark), while the straight requires higher speeds (IMZ) to avoid oval osteotomy morphology, and the cross shape (BIS) enhances internal irrigation. Additionally, the cutter's material affects temperature, with ceramic resulting in the highest and steels the lowest temperatures.

Another variable is the material from which the cutter is made: ceramic resulting in the highest temperature and steel the lowest (Figure 9).

T5 titanium wears more, but it prevents metallic contamination of the surgical site.

Increasing the angle of attack raises the likelihood of tip fractures, while decreasing the angle of attack increases wear. The angle of attack in One Drill cutters is set at 25 degrees, balancing axial and radial forces and requiring less cutting force (Figure 10).

The quality of the bone osteotomy surface and the volume of chips depend on the distance between the drill blades. The optimum distance is between 1.3 and 1.7 mm, with One Drill drills being 1.5 ± 0.3 mm (Figure 11).

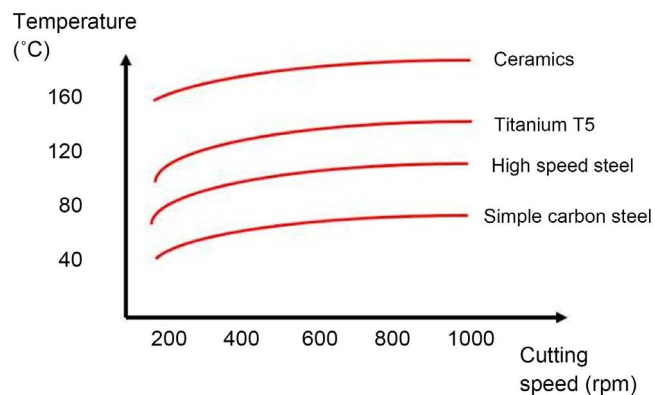


Figure 9. Heat generated when the only variable is the milling cutter material.

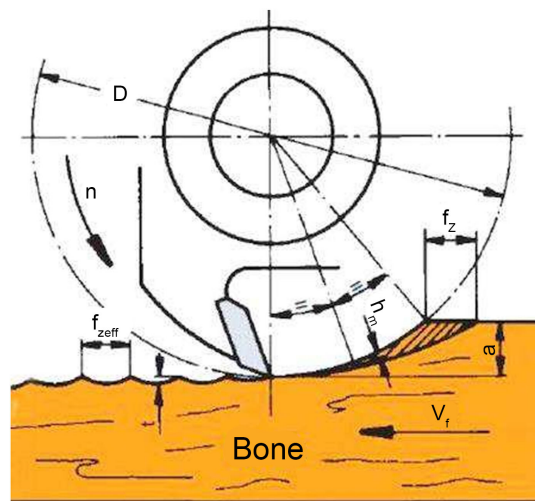


Figure 10. Angle of attack of the milling cutter.

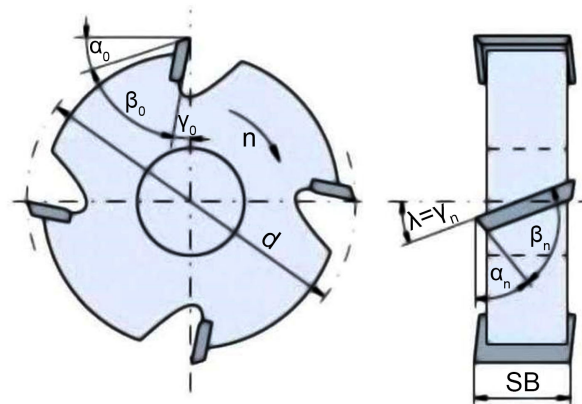


Figure 11. Chip volume as a function of the distance between blades.

If we increase the pitch distance, the quality of the bone surface deteriorates, and the durability of the cutter increases.

Not using irrigation raises the temperature, as previously published by Lemons [35], stating, “the increase in temperature in biological milling is 4 degrees,” a finding supported by our study, which shows an even greater increase.

All three milling techniques maintain the temperature below the critical threshold, ensuring their validity in terms of temperature, provided the opposing factors of speed and cutting force are compensated for. The higher the wear, the lower the speed and cutting force [36].

The professional’s manipulation influences two factors: bone-drill contact time (Brånemark established it at 5 - 6 sec) and the pressure exerted. As these measurements increase, the temperature increases.

The study of the osteotomy morphology was approached indirectly, and no statistically significant difference was observed among the three techniques with regard to the percentage of implant survival during the first three months (primary ossification).

The only statistically significant difference was the time necessary to perform the osteotomy, with the One Drill technique producing the best results.

The “ONE DRILL, ONE IMPLANT” protocol of the manufacturer *One day Biotech* is simple, ergonomic and reliable, with no risk of causing temperature increment above the tolerable limits.

The primary osseointegration rate exceeds 99% of cases and allows implant insertion with 30 to 50 Nw, guaranteeing primary stability in all types of bone. The manufacturer provides a detailed protocol that must be followed.

One Drill burs are made of Trimrite-coated stainless steel, which increases the resistance of the bur and decreases its wear, reducing the increase in temperature due to friction.

All instruments are organized in the “One Drilling Kit”. The initial step involves using the pilot drill, also known as the “Guide Drill”, to mark the osteotomy’s center. The osteotomy is completed with the “One Drill” which

matches the implant's diameter. The depth is controlled by a stopper that aligns with the implant's length.

In Type 1 bone or with a cortical thickness greater than 3 mm, the Counter-sink is used after completing the osteotomy to widen it for implant insertion. Twist Drill drills should be reserved for extremely hard Type I bones.

The advantages of the single drill technique include shorter time, lower temperature increase, lower infection risk, and greater osteotomy uniformity.

The biological technique offers no benefits and increases execution time, infection probability, and the risk of exceeding critical temperature limits.

The sequential technique is very time-consuming, especially when drilling for 4 implants in the same patient session.

The volume of bone harvested using the One Drill technique or the biological drilling technique did not show statistically significant differences, according to Hyun-Chang Lim [37]. With the larger diameter drill, 0.13 cm of autologous bone was ready to be used in guided tissue regeneration. Similarly, Manzano-Moreno [38] measured the bone harvested with helical drills and during biological drilling. In our study, as in Manzano-Moreno's findings, there is a statistically significant difference in the volume of autologous bone harvested between sequential drilling and the One Drill technique, with no significant difference between biological drilling and the One Drill technique.

The size of the bone chips depends on the drill's angle of attack rather than the technique used. With One Day Biotech's One Drill technique, their size ranges between 350 and 550 microns, which is ideal for use in RTG (Figure 12).

The primary stability of the implant, measured using insertion torque and the ISQ, shows no statistically significant differences across the three techniques. Meridith measured the AFR, while Bavetta [39] and Levin [40] measured the ISQ, defining osseointegration of an implant as having a value between 57 and 82. Sannerby (2008) identified failure for a Brånemark implant if its value was below 55, and below 45 for a Strauman implant. Stephan F [41] recommends immediate loading only if its value exceeds 60. In our study, the values ranged from 57 to 81.

Osseointegration at twelve weeks did not show statistically significant differences, coinciding our study with the work of Toyoshima [42] (Figure 13).

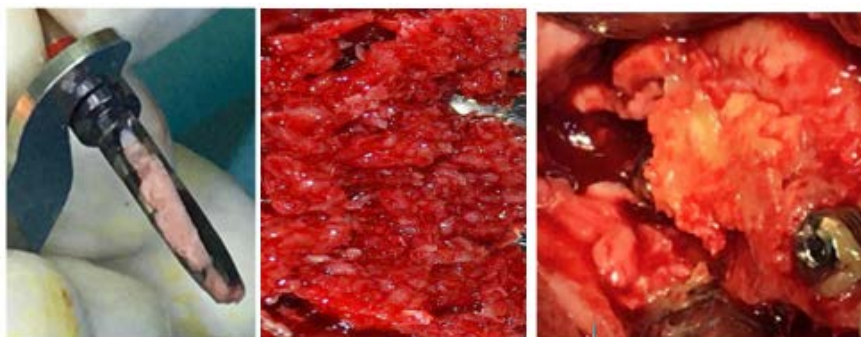


Figure 12. Appearance of harvested autologous bone ready for use in RTG.

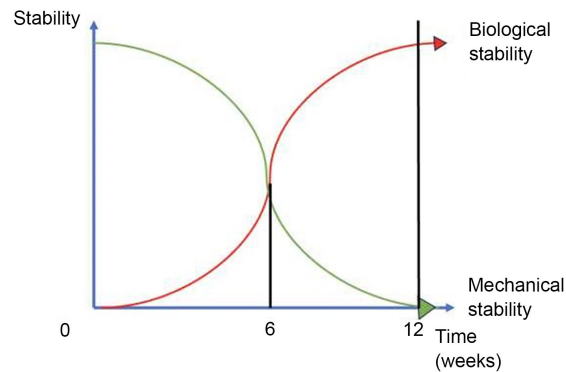


Figure 13. Inverse relationship between biological stability and mechanical stability.

4. Conclusions

- 1) The lowest temperature rise is achieved with the One Drill technique.
- 2) Surgical time is also shorter with a statistically significant difference for the One Drill technique. When comparing the techniques based on temperature increase, time used, risk of infection, and ergonomics, the One Drill technique scores the highest, while biological drilling scores the lowest.
- 3) None of the three techniques exceeds the critical limit of 47 degrees, making them safe for use in implantology practice.
- 4) Regarding the volume of autologous bone harvested, there is no statistically significant difference between the One Drill and biological drilling techniques, both of which are significantly superior to the classic Brånemark technique or “sequential drilling.”
- 5) No statistically significant differences were found between bed preparation techniques and the percentage of osseointegrated implants at 8 weeks.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Brånemark, P.I. (1983) Osseointegration and Its Experimental Background. *The Journal of Prosthetic Dentistry*, **50**, 399-410. [https://doi.org/10.1016/S0022-3913\(83\)80101-2](https://doi.org/10.1016/S0022-3913(83)80101-2)
- [2] Bert, M. and Misika, P. (1993) Complications and Failures in Implantology. Mason.
- [3] Cáceres, F., Troncoso, C., Silva, R. and Pinto, N. (2020) Effects of Osseodensification Protocol on Insertion, Removal Torques, and Resonance Frequency Analysis of BioHorizons® Conical Implants. *Journal of Oral Biology and Craniofacial Research*, **10**, 625-628. <https://doi.org/10.1016/j.jobcr.2020.08.019>
- [4] Brånemark, P.I., Hausson, B.O., Adell, R., Breine, U., Lindström, J., Hallen, O. and Ohman, A. (1977) Osseointegration Implants in the Treatment of the Edentulous JAM. Experience from a 10-Year Period. *Scandinavian Journal of Plastic and Re-*

constructive Surgery, **16**, 1-132.

- [5] Bernabeu, J.C., Soto-Peñaloza, D., Peñarrocha Diago, M.M., Camacho-Alonso, F., Rivas-Ballester, R. and Peñarrocha-Oltra, D. (2021) Low-Speed Drilling without Irrigation versus Conventional Drilling for Dental Implant Osteotomy Preparation: A Systematic Review. *Clinical Oral Investigations*, **25**, 4251-4267. <https://doi.org/10.1007/s00784-021-03939-z>
- [6] Koo, K.-T., Kim, M.-H., Kim, H.-Y., *et al.* (2015) Effects of Implant Drill Wear, Irrigation, and Drill Material on Heat Generation in Osteotomy Sites. *Journal of Oral Implantology*, **41**, e19-e23. <https://doi.org/10.1563/AAID-JOI-D-13-00151>
- [7] Möhlhenrich, S.C., Modabber, A., Steiner, T., Mitchell, D.A. and Holzle, F. (2015) Heat Generation and Drill Wear during Dental Implant Site Preparation: Systematic Review. *British Journal of Oral and Maxillofacial Surgery*, **53**, 679-689. <https://doi.org/10.1016/j.bjoms.2015.05.004>
- [8] Albrektsson, T., Zarb, G. and Worthington, P. (1986) The Long-Term Efficacy of Currently-Used Dental Implants: A Review and Proposed Criterion of Success. *International Journal of Oral and Maxillofacial Implants*, **1**, 11-25.
- [9] Lundskog, J. (1972) Heat and Bone Tissue. An Experimental Investigation of the Thermal Properties of Bone and Threshold Levels for Thermal Injury. *Scandinavian Journal of Plastic and Reconstructive Surgery*, **9**, 1-80.
- [10] Watanabe, F., Tawada, Y., Komatsu, S. and Hata, Y. (1992) Heat Distribution in Bone during Preparation of Implant Sites: Heat Analysis by Real-Time Thermography. *International Journal of Oral and Maxillofacial Implants*, **7**, 212-219.
- [11] Möhlhenrich, S.C., Abounidone, M., Heussen, N., Hölzle, F., Kloeke, F. and Modabber, A. (2016) Thermal Evaluation by Infra Measurement of Implant Site Preparation between Simple and Gradual Drilling in Artificial Bone Block of Different Densities. *International Journal of Oral and Maxillofacial Surgery*, **45**, 1478-1484. <https://doi.org/10.1016/j.ijom.2016.05.020>
- [12] Brånemark, P.I., Breine, U., Adell, R., *et al.* (1969) Intra-Osseous Anchorage of Dental Prostheses: I. *Experimental Studies*. *Scandinavian Journal of Plastic and Reconstructive Surgery*, **3**, 81-100. <https://doi.org/10.3109/02844316909036699>
- [13] Brånemark, P.I., Hasson, B.O., Adell, R., Breine, U., Lindström, J., Hallen, O., *et al.* (1977) Osseointegrated Implants in the Treatment of the Edentulous Jaw. Experience from a 10-Year Period. *Scandinavian Journal of Plastic and Reconstructive Surgery. Supplementum*, **16**, 1-132.
- [14] Eriksson, R.A. and Adell, R. (1986) Temperatures during Drilling for the Placement of Implants Using the Osseointegration Technique. *Journal of Oral and Maxillofacial Surgery*, **44**, 4-7. [https://doi.org/10.1016/0278-2391\(86\)90006-6](https://doi.org/10.1016/0278-2391(86)90006-6)
- [15] Ilzarbe, L.M. and Fernández, A. (1997) The Operating Temperature Transducer (OTT). *Revista Española Odontostomatológica de Implantes*, **5**, 1-18.
- [16] Rivera Vega, M.J., Ballester Ferrandis, J.F. and San Marinas, R. (2006) Bis Implant in the Maxilo-Pterygo-Piramidal Region: Study of 50 Implants and Its State 10 Years Later. *Revista Española Odontostomatológica de Implantes*, **14**, 93-101.
- [17] Mathews, L.S. and Hirsch, C. (1972) Temperatures Measured in Human Cortical Bone When Drilling. *The Journal of Bone and Joint Surgery*, **54**, 297-308. <https://doi.org/10.2106/00004623-197254020-00008>
- [18] Sarendranath, A., Khan, R., Tovar, N., Marin, C., Yoo, D., Redisch, J., *et al.* (2015) Effect of Low-Speed Drilling on Osseointegration Using Simplified Drilling Procedures. *British Journal of Oral and Maxillofacial Surgery*, **53**, 550-556. <https://doi.org/10.1016/j.bjoms.2015.03.010>

- [19] Bettach, R., Taschiari, S., Boukhris, G. and Del Fabbro, M. (2015) Implant Survival after Preparation of the Implant Site Using a Simple Bur: A Case Series. *Clinical Implant Dentistry and Related Research*, **17**, 13-21. <https://doi.org/10.1111/cid.12082>
- [20] Giro, G., Tovar, N., Marin, C., Bonfante, E.A., Jimbo, R., Suzuki, M., *et al.* (2013) The Effect of Simplification in Dental Implant Drilling Sequence on Osseointegration: An Experimental Study in Dogs. *International Journal of Biomaterials*, **2013**, Article ID: 230310. <https://doi.org/10.1155/2013/230310>
- [21] Padhye, N.M., Padhye, A.M. and Bhatavadekara, N.B. (2020) Osseodensification—A Systematic Review and Qualitative Analysis of Published Literature. *Journal of Oral Biology and Craniofacial Research*, **10**, 375-380. <https://doi.org/10.1016/j.jobcr.2019.10.002>
- [22] Branemark, P.-I., Zarb, G.A. and Albrektsson, T. (1985) *Tissue-Integrated Prostheses: Osseointegration in Clinical Dentistry*. Quintessence Publishing, Co In, US.
- [23] Misch, C. (2009) *Implantología contemporánea*. 3rd. Edition, Elsevier, Amsterdam.
- [24] Tretto, P.H.W., Fabris, V., Cericato, G.O., Sarkis-Onofre, R. and Bacchi, A. (2019) Does the Instrument Used for the Implant Site Preparation Influence the Bone-Implant Interface? A Systematic Review of Clinical and Animal Studies. *International Journal of Oral and Maxillofacial Surgery*, **48**, 97-107. <https://doi.org/10.1016/j.ijom.2018.04.005>
- [25] Albrektsson, T., Brånemark, P.I., Hansson, H.A. and Lindstrom, J. (1981) Osseointegrated Titanium Implants: *Requirements for Ensuring a Long-Lasting, Direct Bone-to-Implants Anchorage in Man*. *Acta Orthopaedica Scandinavica*, **52**, 155-170. <https://doi.org/10.3109/17453678108991776>
- [26] Eriksson, R.A. and 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**, 101-107. [https://doi.org/10.1016/0022-3913\(83\)90174-9](https://doi.org/10.1016/0022-3913(83)90174-9)
- [27] Marinesco, I., Rowe, W., Dimitrov, B. and Inasaki, I. (2004) Tribology of Abrasive Machining. In: Marinesco, I.D., Rowe, W.B. and Inasaki, I., Eds., *Tribology of Abrasive Machining Processes*, William Andrew Publishing, Norwich, 587-633. <https://doi.org/10.1016/B978-081551490-9.50016-5>
- [28] Coelho, P.G., Suzuki, M., Guimaraes, M.V.M., Marin, C., Granato, R., Gil, J.N., *et al.* (2010) Early Bone Healing around Different Implant Bulk Designs and Surgical Techniques: A Study in Dogs. *Clinical Implant Dentistry and Related Research*, **12**, 202-208. <https://doi.org/10.1111/j.1708-8208.2009.00153.x>
- [29] Blanco, J., Álvarez, E., Muñoz, F., Liñares, A. and Cantalapiedra, A. (2011) Influence on Early Osseointegration of Dental Implants Installed with Two Different Drilling Protocols: A Histomorphometric Study in Rabbit. *Clinical Oral Implants Research*, **22**, 92-99. <https://doi.org/10.1111/j.1600-0501.2010.02009.x>
- [30] Guazzi, P., Grandi, T. and Grandi, G. (2015) Implant Site Preparation Using a Simple Bur versus Multiple Drilling Steps: 4-Month Post-Loading Results of a Multi-center Randomised Controlled Trial. *European Journal of Oral Implantology*, **8**, 283-290.
- [31] Oh, J., Fang, Y., Jeong, S. and Choi, B. (2016) The Effect of Low-Speed Drilling without Irrigation on Heat Generation: An Experimental Study. *Journal of the Korean Association of Oral and Maxillofacial Surgeon*, **42**, 9-12. <https://doi.org/10.5125/jkaoms.2016.42.1.9>
- [32] Bert, M. (1993) *Osseointegrated Implants*. Masson.

- [33] Sun-Jong, K., Jaeyoung, Y., Young-Soo, K. and Sang-Wan, S. (2010) Temperature Change in Pig Rib Bone during Implant Site Preparation by Low-Speed Drilling. *Journal of Applied Oral Science*, **18**, 522-527. <https://doi.org/10.1590/S1678-77572010000500016>
- [34] Tamburi, A., Massaru, L., Oliveira, S. and Demicheri, G. (2012) Evaluation of Increased Drilling Time Related to Wear of Dental Implant Drills: Pilot Study. *Actas Odontológicas*, **8**, 205-215.
- [35] Lemons, J. (1993) Bone Temperature Measurements from Vital Bone during Bone Surgery. University of Alabama, Tuscaloosa.
- [36] Reingewirtz, Y., Szmukler-Moncler, S. and Sengera, B. (1997) Influence of Different Parameters on Bone Heating and Drilling Time in Implantology. *Clinical Oral Implants Research*, **8**, 189-197. <https://doi.org/10.1034/j.1600-0501.1997.080305.x>
- [37] Lim, H.-C., Ha, K.-I., Hong, J.-Y., Han, J.-Y., Shin, S.-I., Shin, S.-Y., Herr, Y. and Chung, J.H. (2017) Comparison of the Bone Harvesting Capacity of an Intra Oral Bone Harvesting Divide and Three Different Implant. *BioMed Research International*, **2017**, Article ID 7819080. <https://doi.org/10.1155/2017/7819080>
- [38] Manzano-Moreno, F.J., Herrera-Briones, F.J., Linares-Recatala, M., Ocaña-Peinado, F.M., Reyes-Botella, C. and Valdecillo-Capilla, M.F. (2015) Bacterial Contamination Levels of Autogenous Bone Particles Collected by 3 Different Techniques for Harvesting Intraoral Bone Grafts. *Journal of Oral and Maxillofacial Surgery*, **73**, 424-429. <https://doi.org/10.1016/j.joms.2014.10.020>
- [39] Bavetta, G., Bavetta, G., Randazzo, V., Cavataio, A., Paderni, C., Grassia, V., *et al.* (2019) Clinical Study: A Retrospective Study on Insertion Torque and Implant Stability Quotient (ISQ) as Stability Parameters for Immediate Loading of Implant in Fresh Extraction Sockets. *BioMed Research International*, **2019**, Article ID: 9720419. <https://doi.org/10.1155/2019/9720419>
- [40] Levin, B.P. (2016) The Correlation between Immediate Implant Insertion Torque and Implant Stability Quotient (ISQ). *International Journal of Periodontics & Restorative Dentistry*, **36**, 833-840. <https://doi.org/10.11607/prd.2865>
- [41] Balshi, S.F., Allen, F.D., Wolfinger, G.J. and Balshi, T.J. (2005) A Resonance Frequency Analysis Assesment of Maxillary and Mandibular Inmeediately Loaded Implants. *International Journal of Oral and Maxillofacial Implants*, **20**, 584-594.
- [42] Toyoshima, T., Warner, W., Klein, M.O., Stender, E., Wieland, M. and Al-Nawas, B. (2011) Primary Stability of a Hybrid Self-Tapping Implant Compared to a Cylindrical Non-Self-Tapping Implant with Respect to Drilling Protocols in an *ex vivo* Model. *Clinical Implant Dentistry and Related Research*, **13**, 71-78. <https://doi.org/10.1111/j.1708-8208.2009.00185.x>