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Hybrid and fully-etched surface implants in periodontally healthy patients: A comparative retrospective study on marginal bone loss

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Abstract

Background: Human studies on implants with the same design but with different surfaces are lacking at the present time.

Purpose: The aim of this study was to compare the survival rate of and marginal bone loss (MBL) around 2 types of implants with the same design, but with different surfaces: fully "sandblasted and double-etched" (SDE) implants and hybrid (H) implants, with an apical SDE-surface and a coronal machined-surface.

Materials and methods: The SDE- and H-surfaces were previously analyzed under SEM and profilometer. Implants were placed in partially edentulous periodontally healthy patients requiring single implant-restoration, in either mandible or maxilla, with cement-retained prosthetic restoration. Twelve months after prosthetic loading, MBL in relation to prosthetic abutment height (AH), calculated radiographically, was statistically analyzed.

Results: SEM and profilometer analyses revealed no differences between the SDE-surfaces of either SDE- or H-implants. Transverse ridges and grooves characterized the machined portion of H-implants, clearly influencing the profilometer analysis. In 75 patients, 37 SDE and 38 H-implants were placed and all functioned completely after 12 months. In both SDE- and H-groups, MBL had a significant inverse relationship with AH, with greater intercept and negative slope for SDE-group and intersection of the 2 regression lines at AH = 2 mm.

Conclusions: A 100% survival rate was recorded for SDE- and H-implants placed in pristine bone of periodontally healthy patients; MBL was limited and similar in both SDE- and H-groups; the higher the prosthetic AH, the lesser the MBL around implants; H-implants could reduce bone loss most effectively with abutments lower than 2 mm, realistically exploitable on thin biotypes; SDE-implants could reduce bone loss most effectively with abutments greater than 2 mm, realistically exploitable on thick biotypes.

KEYWORDS
abutment height, hybrid surface implants, marginal bone loss, periodontally healthy patients, retrospective, sandblasted and double etched surface implants, short-term

1 | INTRODUCTION

Rehabilitation of partially or totally edentulous patients with implants is a worldwide practice in dentistry, with well-established and predictable procedures confirmed in numerous studies. The first documented case of implant rehabilitation dates from approximately half a century ago, and the first long term review was published 35 years ago. Implant therapies can be considered highly successful, as survival rates ranging from 85%

to 99% have been reported.[1–3] Mandibular implants have shown higher success rates when compared with maxillary implants.[1,4,5] Several explanations have been advanced to justify this difference, but higher quality and density of jaw bone play a fundamental role.[2]

Many implant types, with different structure and design, have been proposed to improve performance and increase implant success, but all implants kept the traditional machined surface for 35 years or more. Over the last 12 years, however, machined surfaces have been widely replaced by so-called "osseoconductive" surfaces (titanium plasma sprayed, hydroxyapatite (HA) coated, or acid etched surfaces), with the purpose of increasing bone-to-implant contact (BIC) and ensuring faster and better osseointegration. In regenerated sites, such as augmented maxillary sinuses, the survival rate of implants with osseoconductive surfaces has indeed demonstrated to be higher when compared to implants with machined surfaces.[6] Implants with osseoconductive surfaces performed better both clinically and histologically, in both pristine and grafted bone. Human histological and histomorphometric studies demonstrated greater BIC around implants with osseoconductive surfaces when compared to implants with machined surfaces.[7,8] On the contrary, clinical effects of implant surfaces on long-term success seems to play a minor role in terms of implant survival rates.[9–12] Moreover, an experimental study showed that both HA and titanium plasma-spray surfaces accelerated peri-implantitis progression with consequent higher failure rates.[9] Reports of alarming failure rates of fully etched-, HA-, or TPS-treated implants indicated that a osseoconductive surface near the implant-abutment connection could increase mucosal complications and indicated that the bacterial biofilm could be more easily debrided in presence of a machined surface.[13]

Evaluating different implants surfaces, a systematic review showed a 20% lower risk of peri-implantitis around machined implants over a 3-year follow-up period.[10] When machined implants are utilized, the risk of peri-implantitis could be considered only less probable as evidenced in a retrospective study by Simion and colleagues.[14] Furthermore, a recent study found that also implants with rough surfaces had a 20% increased risk of facilitating peri-implantitis over a 3-year period.[12] The claim that machined-surface implants reduce peri-implantitis and consequent bone loss more successfully than osseoconductive-surface implants, however, remains controversial.

The positive effects of machined surfaces on peri-implant soft tissue has been evidenced in a human study in which histological samples were taken from machined and acid-etched titanium healing abutments and were compared.[15] Therefore, considering different findings and differing behavior of different surface treatments, a hybrid implant design has been developed and produced commercially to better exploit the advantages of machined and etched surfaces. It has, in fact, been hypothesized that this hybrid design could better ensure mucosal health and lower the risk of peri-implant disease in osseointegrated implants over time. A machined surface in the coronal region could reduce the risk of peri-implantitis, whereas an apical etched surface could, conversely, guarantee a rapid and effective osseointegration and high BIC. However, only few short- and medium-term clinical scientific investigations with limited sample sizes have been carried out at present.[13,16,17]

A machined surface around the implant coronal portion could determine increased crestal bone loss compared to an etched surface,[1,18] particularly during the time between implant positioning and the first year of loading.[13,14] The surface of the implant coronal portion was not the primary factor in limiting marginal bone loss (MBL). Actually, it has already been well-established that MBL amount is mainly related to implant neck design and to connection type, and that the platform-switching design[19] and the internal connection[20] can both statistically reduce MBL around implant necks. Additionally, the prosthetic abutment height (AH), calculated as the distance from implant platform to the apical edge of the crown, was also a key factor in limiting MBL progression, as Galindo-Moreno and colleagues demonstrated in 2014.[21]. On multiple unit implant screw-retained prostheses, lesser MBL was recorded around long prosthetic abutments than with short prosthetic abutments.[21,22] This inverse relationship between MBL and AH has also recently been found around implant cement-retained prostheses.[23]

The aim of this retrospective study was to analyze survival of and bone loss around implants of the same design but different surface finish, specifically: either sandblasted and double etched (SDE) or machined/SDE (hybrid) surface, placed in partially edentulous patients for 12 months.

2 | MATERIAL AND METHODS

Partially edentulous patients requiring a single implant-restoration in either mandible or maxilla posterior areas (from first premolar to second molar) and while undergoing cement-retained prosthetic restoration, and fulfilling all inclusion criteria, were examined and treated by 2 private dental operators (S.S., F.B.) in 2 independent offices.

Contrary to public and private health centers (DM 18/3/1998 published in the Official Gazette, GU n. 122 of 28-05-1998), Italian law does not require ethical committee approval for clinical work performed in private dental offices and therefore no ethical committee resolution is released. Nevertheless, all patients signed informed consent in which all procedures of the study were detailed. All research was conducted in full accordance with ethical principles, including 2008 WMA Helsinki Declaration.[24]

Inclusion criteria for the study were: patients should be at least 18 years of age; good general health; presence of adequate bone volume to achieve implant primary stability no concomitant or previous alveolar crest regenerative procedures. Additional inclusion criteria were: at least 8 mm of basal bone height below the maxillary sinus or at least 9 mm above the mandibular canal.

Exclusion criteria were: poor oral hygiene and motivation, smoking habits, active infection, absence of keratinized mucosa, and lack of occlusal contacts with the opposing dentition. Additional exclusion criteria were: presence of diseases affecting bone metabolism or wound healing; history of head or neck radiation therapy; regular medicinal consumption of steroids, tetracycline, bisphosphonate or other medication affecting bone turnover and patient pregnancy at any time during the study.

Clinical and radiographic diagnoses of patients revealed no clinical or radiographic signs of chronic periodontitis at the time of the first visit. Patients were, however, instructed in oral hygiene before implant placement. To evaluate crestal bone width and height and sinus health of all patients, CBCT scans were taken before surgery.

Before implant placement, a preliminary analysis of the surface morphology of implants was performed by scanning electron microscope (ESEM Quanta 200 (FEI), using a low vacuum (LV-SEM) water saturated conductive atmosphere allowing analysis of an implant surface with no metal sputtering or other alteration that may compromise further investigation.[25] Quantitative evaluations of implant surfaces were then performed using a specific profilometry, white-light confocal profilometry, capable of analyzing curved and sloped surfaces (Open Platform with ConScan confocal microscopy, CSM, Peseux, Neuchatel, Switzerland), with implants horizontally positioned under the confocal microscope to minimize additional geometrical complications.[25] On each surface type, a 70 × 30 micron-rectangle was the evaluation area. The longer side of the rectangle was oriented parallel (y-axis), to the cylindrical axis of the implant, to intersect the greatest numbers of ridges and grooves. A raster scan type acquisition, consisting of 15 scan lines with 70 points on each line, was performed. Five surface profiles were acquired on each surface type. The profiles were elaborated with mean plane subtraction and polynomial background removal (Image plus 2.19, CSM, Peseux, Neuchatel, Switzerland) to remove surface curvature effects. Surface profiles were then used to evaluate the following quantitative roughness parameters: maximum height of the profile (Rt), mean roughness (Ra), mean roughness depth (Rz), skewness (Rsk), and average wavelength (λa). Rz, Rsk, and λa) were calculated along the X and Y axes of the surface, that is, transverse and longitudinal to the cylindrical axis of the fixture, with 5 evaluations for each axis.[25]

2.1 | Implant placement and prosthetic delivery

A 2-stage protocol was adopted according to the manufacturer's recommendation: the implant site was prepared to allow a crestal positioning of the implant neck. Under local anesthesia, a full-thickness flap was opened and the implant site was initiated with a small-diameter pilot-drill using a prefabricated surgical guide. No vertical soft tissue thickness measurement was performed in analyzed patient pool either at implant placement or re-opening appointment.

Two types of 3.75 millimeter-diameter implants were used in this study: (1) Shape1BC (I-RES, Lugano, Switzerland), with a SDE surface and 1 mm polished collar neck; and (2) Shape1-Hybrid (I-RES, Lugano, Switzerland), with a machined surface of the coronal third and a SDE-surface of the 2 apical thirds. All implants were initially fully machined by titanium turning, and, after coronal part protection of hybrid implants, SDE-surfaces were obtained by sandblasting and double etching in both implant types. The 2 implant types, both titanium grade 4, had the same macro-design: screw pitch, tapered, neck design, platform-switched and internal connection. The operator could choose from 4 implant lengths (8.0, 10.0, 11.5, and 13.0 mm).

All implants were submerged. After postoperative antibiotic and germicide mouthwash treatment, sutures were removed 12 to 14 days after surgery. Patients used no removable prostheses during the healing period. The time between implant placement and exposure was 3 to 4 months. Healing abutments were placed during this second surgical phase and implant-supported prostheses were delivered approximately 4 weeks later. The height of the customized titanium abutments used to connect crown to implant were chosen individually not only in function of the site-specific soft tissue thickness, but also to obtain optimal crown retention and an acceptable aesthetic emergence profile. The finished abutments were tightened to 30 Ncm and all single-tooth restorations were cemented. A thin layer of petroleum jelly was placed on the apical margin of the crown immediately before cementation to facilitate excess cement removal from the porcelain surface. After cementation, particular care was taken to remove excess cement using curettes and dental floss. This same procedure was accurately re-performed 1 week later by an external hygienist. During this procedure, both dental operator and external hygienist used (×2.5) magnification optical lenses.

2.2 | Radiography

To ensure standardization of measurements, digital radiographs were taken using a long-cone paralleling technique with a Rinn-type film holder at the time of surgical implant placement, final prosthetic restoration delivery (baseline) and 12 months after prosthetic loading. MBL was calculated by linear measurement taken from the most mesial and distal points of the implant platform (Figure 1) to crestal bone on each radiograph corrected referring to the known height and diameter of each implant. The vertical distance between the most mesial and distal points of the implant platform and the most coronal bone-to-implant contact was measured on both mesial and distal sides of each radiograph at baseline and at 12-month follow-up. Mesial and distal MBL was calculated as bone change between baseline and 12-month follow-up (Figure 1).

The AH was calculated by linear measurements taken from the most mesial and distal points of the implant platform to the most mesial and distal points of the lowest point of the edge of the cemented crown (Figure 1).

Radiographs showing signs of deformation, darkness or other complications were retaken. Blind measurements were performed to the nearest 0.01 mm using Kodak Digital Imaging Software (Kodak, Eastman Kodak, Rochester, New York) by a single independent examiner (D.Z.).

2.3 | Statistical analysis

Primer of Biostatistics 6th Ed. Software was used for statistical analysis.[26] Comparisons were performed by means of the one-way ANOVA test. Simple linear regression was used to analyze trends. Overall analysis for coincidence was performed to compare the 2 regression lines. The critical significance level of $P < .05$ was used to reject the null hypothesis H_0.

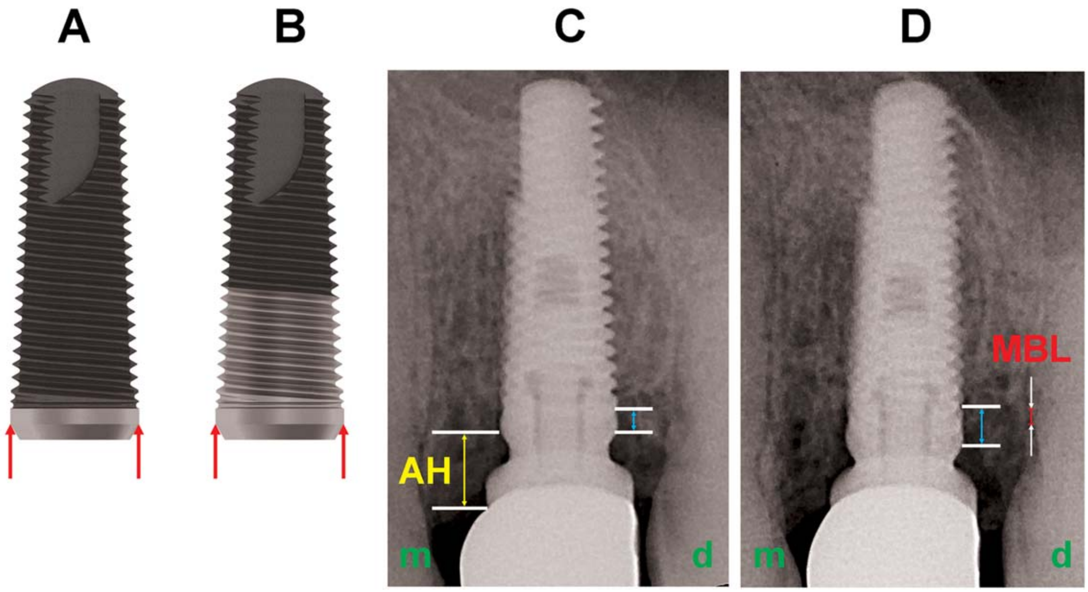

FIGURE 1 The red arrows indicate reference points in A, sandblasted and double etched surface, and B, hybrid surface implants. Representative radiographs of an implant, at C, baseline, and D, after 12 months, showing marginal bone loss (MBL) and abutment height (AH) calculations, mesially (m) and distally (d). MBL was calculated by linear measurement of the distance between the most mesial and distal points of the implant platform and the most coronal bone-to-implant contact, and AH was calculated as the distance from the most mesial and distal points to the lowest point of the edge of the crown

3 | RESULTS

SEM analyses showed that the thread surface of SDE-implants was almost identical excepting the crests of the threads (Figure 2). The surface of the thread crest resulted very irregularly shaped with high peaks and several valleys, some of which very deep (Figure 2). The surface of thread sides resulted almost identical along the whole implant and, additionally, showed a SDE-surface with several peaks rising irregularly from

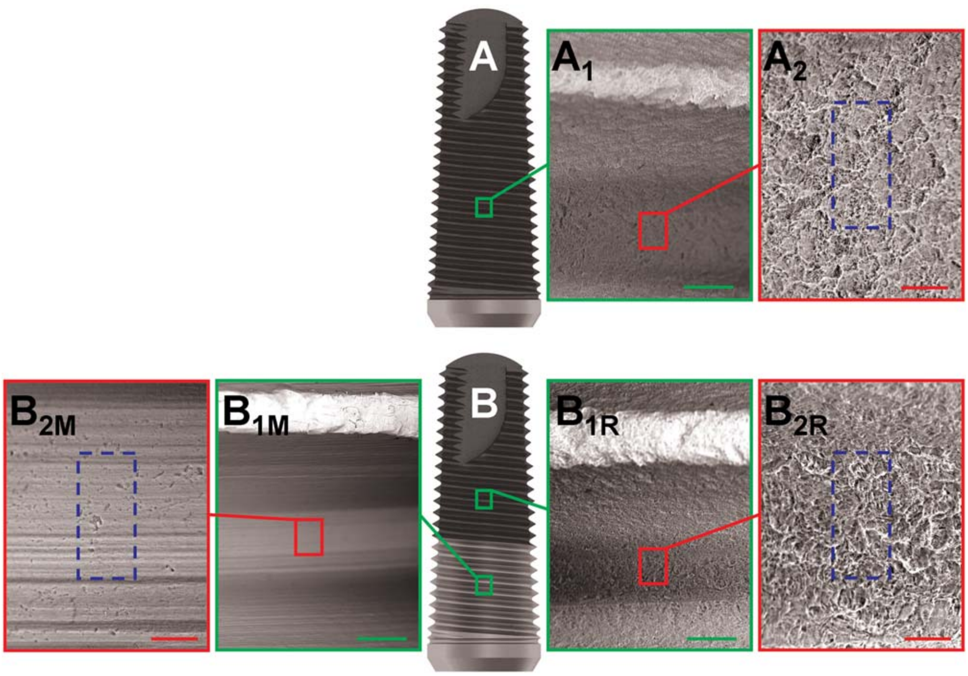

FIGURE 2 Representative SEM images of sandblasted and double etched (SDE) surface implants (A), and hybrid (H) surface implants (B). The A and B boxed areas show the surface of the thread crest and of almost identical thread sides between SDE-implants (A_1) and the apical SDE portion (B_{1R}) of H-implants. On the contrary, the corresponding surfaces of the coronal machined portion ($B_{1M)}$ of H-implants resulted quite unlike both in terms of crests and thread sides. The A_2, B_{2R} and B_{2M} boxed areas correspond to areas analyzed by profilometer. (Bar: A_1, B_{1R}, B_{1M} = 100 μm; A_2, B_{2R} and B_{2M}, = 25 μm

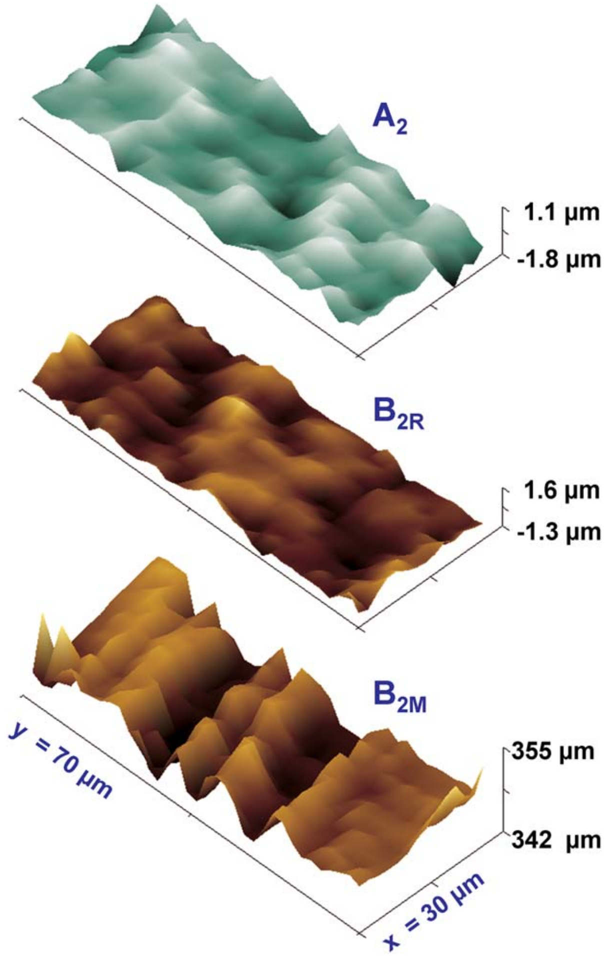

FIGURE 3 Representative profilometer analyses showing the surface of thread sides of sandblasted and double etched (SDE) surface implants (A_2), and of the SDE portion (B_{2R}) and machined portion (B_{2M}) of hybrid implants (B). Note the qualitative and quantitative similarity of the SDE surfaces (A_2 and B_{2R}). Note also transverse ridges and grooves forming the surface of the machined portion of hybrid implants (B_{2M})

an almost flat surface (Figure 2). In the apical SDE-portion of hybrid implants, SEM analyses showed that thread crests had an appearance similar to that of SDE-implants, but with shorter peaks, while the surface of thread sides resulted almost identical to that of SDE-implants (Figure 2). On the contrary, around the coronal machined (turned) portion of hybrid implants, the surface of the thread crest appeared almost flattened and the surface of the thread sides showed the presence of ridges and grooves transverse to the implant axis (Figure 2).

Profilometry confirmed that thread surfaces of the apical SDE-portion of hybrid implants had the same appearance as that of SDE-implants, with a similar Rt of 2.5 to 3.5 μm (Figure 3). On the contrary, as observed under SEM, the thread surface of the cervical machined (turned) portion of hybrid implants was furrowed by parallel ridges separated by grooves, sometimes very deep, showing a greater Rt of 11 to 15 μm (Figure 3). Table 1 reports the mean Ra, Rz-X, Rz-Y, Rsk, and λa values, and the related ANOVA statistical test, for each of these profilometries.

Of a total of 80 consecutive patients (39 SDE-implants and 41 H-implants), 5 patients failed to complete all phases of the study allowing retrospective analysis of a total of 75 patients. A total of 37 SDE-implants (SDE-group) and 38 hybrid implants (H-group) were placed in those 75 periodontally healthy patients. Twenty-six SDE-implants and 25 H-implants were inserted in maxilla, whereas 11 SDE-implants and 13 H-implants were inserted in mandible. The distribution of implants by length was: 8 mm = 9 (5 SDE; 4 H), 10 mm = 24 (12 SDE; 12 H), 11.5 mm = 25 (13 SDE; 12 H), and 13 mm = 17 (7 SDE; 10 H). The mean age of patients of SDE-group (17 females and 20 males) was 49.6 years, while that of H-group (19 females and 19 males) was 52.9, without statistical significance after ANOVA test ($P = .23$). Primary wound closure was obtained in all surgeries and no complaints or adverse effects were registered or observed during follow-up. All 75 implants positioned were functioning at the 1-year follow-up time with 100% survival. No implant described probing depth exceeding 5 mm.

Within SDE- and H-groups, no statistical difference ($P > .5$) was found when comparing average mesial and distal MBL (overall mMBL: SDE-group—range 0.0–1.41 mm; H-group—range 0.0–0.95 mm; overall dMBL: SDE-group—range 0.0–1.27 mm; H-group—range 0.0–

TABLE 1 Profilometry of side surface of implant threads

				Hybrid implants		
		SDE implants		SDE surface		Machined surface
	Ra (μm)	0.42 ± 0.17	n.s.	0.53 ± 0.11	$P < .01$	2.42 ± 0.36
x-axis	Rz (μm)	0.57 ± 0.25	$P < .03$	0.96 ± 0.28	$P < .03$	1.29 ± 0.35
	Rsk	0.10 ± 0.14	...	−0.09 ± 0.17	...	−0.08 ± 0.35
	λa (μm)	13.98 ± 2.45	...	8.08 ± 1.35	...	12.33 ± 3.71
y-axis	Rz (μm)	0.87 ± 041	n.s.	0.89 ± 0.28	$P < .01$	5.01 ± 0.99
	Rsk	−0.13 ± 0.10	...	0.03 ± 0.16	...	−0.07 ± 0.41
	λa (μm)	16.48 ± 2.76	...	28.02 ± 3.03	...	18.98 ± 7.23
			ANOVA		ANOVA	

Abbreviation: λa, Wavelength; Ra, Roughness; Rsk, Skewness; Rz, Roughness depth; SDE, sanded and double etched.
n = 10 − mean ± SD values.
n.s., not significant after ANOVA test ($P > .05$).

TABLE 2 Average values of mesial and distal marginal bone loss

		SDE implants mm		Hybrid implants mm
Maxilla	mMBL	0.30 ± 0.34	n.s.	0.32 ± 0.23
	dMBL	0.38 ± 0.37	n.s.	0.33 ± 0.27
Mandible	mMBL	0.46 ± 0.30	n.s.	0.25 ± 0.22
	dMBL	0.48 ± 0.30	n.s.	0.39 ± 0.30
Overall	mMBL	0.35 ± 0.24	n.s.	0.29 ± 0.23
	dMBL	0.41 ± 0.35	n.s.	0.35 ± 0.27
			ANOVA	

Abbreviation: dMBL, distal marginal bone loss; mMBL, mesial marginal bone loss; SDE, sanded and double etched.
mean ± SD values are reported as millimeters.
n.s., not significant after ANOVA test ($P > .05$).

1.25 mm), and, similarly, no statistical difference ($P > .5$) was found for maxilla and mandible comparisons (Table 2).

In both SDE- and H-groups the simple linear regressions of both mesial and distal MBL had a significant inverse relationship ($P < .001$) with their corresponding AHs (Figure 4). Specifically, MBL was greater (0.8–1.4 mm) when AH is close to 0 mm, while MBL was close to 0 mm when AH is significantly greater (2–3 mm). Both mesially and distally, the SDE-regression line had intercept and negative slope (1.1 and 0.4, respectively) of greater value, and the H-regression line had intercept and negative slope (0.6 and 0.14, respectively) of lower value (Figure 4). The overall analysis of the coincidence of the regression lines of SDE- and H-groups showed a statistical significance (degrees of freedom: 2 numerator and 71 denominator—mesial: $F = 9.02$, $P = .001$; distal: $F = 3.59$, $P = .0033$) between the 2 lines.

The 2 regression lines intersected at AH = 2 mm, and the theoretical minimum AH annulling the MBL was: 2.7 mm (SDE) and 4.7 mm (H) at the mesial aspect, and 3.0 mm (SDE), and 4.4 mm (H) at the distal aspect (Figure 4).

4 | DISCUSSION

In the present clinical and radiographic comparison between hybrid-surface and SDE-surface implants no failure was recorded in either group. Specifically, the mean MBL evaluated around SDE implants was very limited and not statistically significantly different from the mean MBL of hybrid implants 1 year after implant placement. This result partially disagreed with a 5-year study comparing fully etched and hybrid implants in which more crestal bone loss was recorded in implants with a coronal machined surface after only 1 year of loading.[13]

However, the implants examined in the aforementioned study were non-platform-switched implants with an external connection. Conversely, other studies demonstrated that the amount of bone loss is, in fact, mainly related to implant design and type of connection. Recent clinical trials have established that the platform-switching design reduces MBL,[19] and that an external connection gives rise to greater bone loss than an internal connection.[20] All implants positioned and examined in the present study had the same macro-geometry with a platform-switching design and an internal connection.

Supposedly, machined surface implants show more MBL than etched surface implants, as demonstrated in studies in which smooth implant collars were placed at or below the alveolar crest.[18,27] Nevertheless, additional factors could explain such crestal resorption. First, the subcrestal positioning of the implant-abutment micro-gap would almost certainly increase bone remodeling.[18] Second, the frequently referred to "smooth collar" has not always been well-defined or analyzed in terms of relative roughness due to uncertainty regarding the machined or polished neck surface.[28] In the present study the SEM and profilometer analyses of the coronal machined portion of hybrid

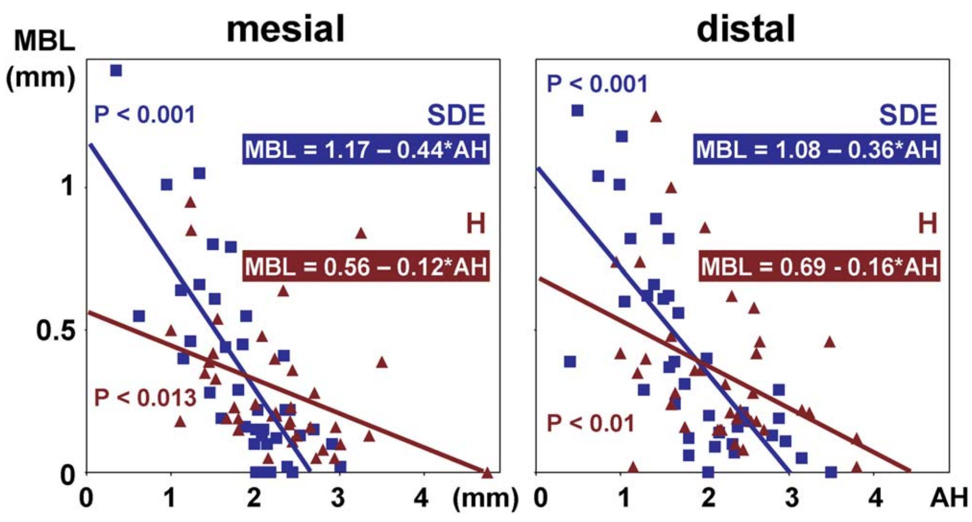

FIGURE 4 Trend of mesial and distal marginal bone loss (MBL—y-axis), recorded 12 months after implant insertion in relation to mesial and distal abutment height (AH—x-axis) of the 75 patients. Note in both sandblasted and double etched (SDE) implant and hybrid (H) implant groups: (1) the inverse relationship between marginal bone loss and abutment height, (2) the highly significant correlation of all regression lines, (3) the lower intercept values of H-group regression lines, (4) the greater slopes of SDE-group regression lines, and (5) the intersection of the 2 regression lines at AH = 2 mm

implants showed the presence of sometimes very deep ridges and grooves (deeper than those in the so-called “etched” surface) which might have positive effects on osseointegration processes. A clinical study on etched and machined surface-implants placed in human revealed similar outcomes with no statistical differences in bone loss,[29] and, additionally, a more recent histologic study on dog mandibles has shown that osseointegration follows a similar healing pattern around both oxidized and machined surfaces.[30]

Compared to SDE-implants, the advantages of hybrid implants are twofold: first the SDE-surface along the implant body promotes osseointegration,[31] and second, surface charge and surface energy of the machined surface can strongly influence bacterial adhesion[32] along its coronal portion, decreasing the risk of peri-implantitis.[12,33] Our evaluation of SDE and hybrid implant-surfaces revealed qualitative and quantitative similarity of SDE-surfaces in the 2 implant types, but a greater roughness value (Ra and Rz-Y) of the coronal machined (turned) part of hybrid implants. The roughness values recorded for the machined (turned) surfaces fall within the normal range for this surface category.[34] The roughness values recorded for the etched surfaces are similar to those found by Rosa and colleagues, analyzing sandblasted and acid-etched implants.[35]

Some studies have suggested that a limited amount of MBL, ranging between 1.5 and 2.0 mm, could occur to provide a vertical space for biologic width reestablishment around the implant neck,[36] and remains stable over time after prosthetic restoration delivery.[37] Linkevicius and colleagues[38] hypothesized that vertical soft tissue thickness may serve as a protective mechanism for underlying crestal bone and therefore may be an important factor in peri-implant bone loss reduction. In fact, vertical soft tissue thickness greater than 2 mm significantly preserved crestal bone around implant necks after 1 year.

However, recent investigations have demonstrated that the shorter the prosthetic AH, the greater the crestal bone around implants both with screw-retained[21,22] and cement-retained prostheses.[23] Specifically, the ideal distance from the prosthetic restoration to the bone crest to limit bone loss was evaluated in these studies to be 2 mm or more.[21,22]

Vervaeke and colleagues[39] hypothesized that AH should reflect vertical soft tissue thickness. In other words, AH decisions can be determined by peri-implant soft tissue thickness. According to this view, one can presume that prosthetic AH and vertical soft tissue thickness must obey the proposition: a vertical space of at least 2 mm around implant abutments must be provided for the biological width reestablishment. In this retrospective study, no vertical soft tissue thickness measurement was performed. Nevertheless, it was observed during the prosthetic procedure that in some clinical situations prosthetic AH reflected vertical soft tissue thickness to allow good fitting (adaptation) to site-specific soft tissue thickness as hypothesized by Vervaeke and colleagues.[38] Conversely, in other clinical situations shorter abutments should be chosen to maximize cemented crown retention and/or to improve aesthetic emergence profiles and, therefore, in the latter situations, AH should not reflect soft tissue thickness.

This present study represents additional confirmation of the following concept: an inverse relationship between MBL and AH was found for both implant types. However, despite both implant types having statistically similar MBL, the trend of MBL in relation to AH between the 2 implants was quantitatively different, with the regression line intersection at 2 mm. As a consequence, the AH at which MBL became zero was estimated as being 2.7 mm mesially and 3 mm distally for SDE implants and 4.7 mm mesially and 4.4 mm distally for hybrid implants. Simply stated, hybrid implants can reduce bone loss better than SDE implants when short prosthetic abutments (lower than 2 mm) are utilized. On the contrary, SDE implants can preserve crestal bone more consistently than hybrid implants when long abutments (greater than 2 mm) are utilized.

Therefore, a prosthetic abutment longer than 2 mm is desirable to minimize bone loss around implants. In all the aforementioned clinical situations, where a shorter prosthetic abutment is needed, hybrid implants could better limit crestal bone loss than SDE implants. However, further investigation is necessary to fully understand the exact process involving MBL around hybrid and SDE implants.

5 | CONCLUSIONS

Within the limits of this short-term study, the following conclusions can be drawn: (1) in periodontally healthy patients hybrid and SDE implants provided a 100% survival rate in pristine bone; (2) the recorded amount of MBL was very contained and similar around hybrid and SDE implants; (3) the higher the prosthetic AH, the lesser the MBL around both implant types; (4) hybrid implants more consistently reduce bone loss when abutments are lower than 2 mm; and (5) SDE implants more consistently preserve crestal bone when abutments are greater than 2 mm.

Long-term studies on hybrid implants are required, however, to evaluate MBL progression over time and its relation to soft tissue thickness.

CONFLICT OF INTEREST

This study was self-funded. The authors claim to have no financial interest, either directly or indirectly, in the products or information listed in the article.

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