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Which dental implant surface is more effective in osteointegration: RBM surface versus SLA surface

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Abstract
Aim: The surface characteristics of an implant direct the wound healing and are an important factor for osteointegration. There are very few studies evaluating or comparing the clinical success of osteointegration of sandblasting with larger grit and acid etching (SLA) and rough surface as required by grit blasting (RBM) surfaces, which are important surface factors in selecting an implant. The aim of this study was to evaluate the osteointegration success in a total of 4793 implants in 2005 patients in SLA and RBM surface cylindrical implants of the same trademark and type.
Material and Methods: A total of 4793 implants and 2005 patients composed of 943 females and 1062 males were included in this study. Regions of implant applications were grouped into anterior and posterior parts of the mandible and anterior and posterior parts of the maxilla and evaluated with success rates.
Results: Among the implants, 1877 were RBM surface and the remaining 2675 had SLA surface. Seventy-four implants among the 1877 RBM surface implants failed (%96.06). The success rates were 94.75 % and 97.22%, maxilla and mandible, respectively. Among the 2675 SLA surface implants, 93 failed (%96.53). The success rates were 95.29% and 97.11% in maxilla and mandible, respectively.
Discussion: Recently, the studies have demonstrated increased bone and implant contact areas and a high degree of osteoconductive property when applied to surfaces in histological studies. In the presented study, RBM and SLA surface implants with the same trademark and same design were clinically compared, and no significant difference was found between them in terms of osteointegration success.

Keywords
Dental implant; Implant surface; Osteointegration

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Introduction

Osteointegration was first defined by Brenemark et al. as fusion development between mature bone and implant without any soft tissue formation. Brenemark et al. also evaluated the factors affecting osteointegration in models in which they applied screw-type implants in canine mandibles and they reported that the depth of the implant in the bone and atraumatic procedures affected the osteointegration [1]. Nevertheless, Albrektsson et al. placed cylindrical implants in adult canine mandibles and evaluated the osteointegration microscopically. The results of the study revealed that osteointegration required a time period of 3 to 4 months [2]. Brenemark et al. in their electron microscopic study reported that structures in irregular layers were present between an implant and bone although they seem to be in contact with each other directly. They reported that the surface characteristics of an implant direct the wound healing and is an important factor for osteointegration. Bone growth has been observed to be more rapid and physical adhesion has been seen to be more successful in cases in which rough-surface dental implants were used [2,3]. Many studies have been performed with rough surface dental implants; osteoblast adherence has been seen to be much better in those implants and maturation and differentiation have been reported to be much faster in the cells adhered to the implant surface. At the same time, bone-implant contact in far greater rates and higher removal torque values have been seen in rough surface dental implants compared to machine- polished implants [2,3].

Among the implant surface types are hydroxyapatite coating [4], acid etching [5], blasting [6], sandblasting with larger grit and acid etching (SLA) [7].

The aim of the RBM technique is to provide a rough surface as required by grit blasting. Bioceramics used in the RBM technique decrease the possible biocompatibility issues by particle embedding on the implant surface of particle detachment [8]. SLA surface is made by sandblasting the implant surface by aluminum oxide (Al2o3) or titanium oxide (Tio2) particles and subsequently roughing this surface using hydrochloric acid or sulphuric acid [10]. Buser et al. reported higher removal torque values and more rapid osteointegration in SLA surface implants compared to implants with other surface properties [9].

SLA surface technique is a technique of surface roughing preferred by many implant manufacturers. Also, RBM is another technique that has recently been applied by implant manufacturers. Studies evaluating or comparing the clinical success of osteointegration of SLA and RBM surfaces which are important surface factors in selecting an implant are very few. The aim of this study was to evaluate the osteointegration success in a total 4793 implants in 2005 patients in SLA and RBM surface cylindrical implants of the same trademark and type (EBI Precision 1.8, KOREA).

Material and Methods

The permission for the study was taken from the Local Ethics Committee, and it has been conducted in full accordance with the World Medical Association Declaration of Helsinki. A total of 4793 implants and 2005 patients composed of 943 females and 1062 males were included in this study. Regions of implant applications were grouped into anterior and posterior parts of the mandible and anterior and posterior parts of the maxilla and evaluated with success rates. Patients who smoked cigarettes had poor oral hygiene, uncontrolled diabetes, chronic renal and liver disease, and metabolic bone disorder and hemophilia and immunocompromising disease or had received radiotherapy to the head and neck region or antiblastic chemotherapy or implants placed with maxillary sinus lifting were excluded from the study. Criteria of the success of an implant were defined as stable implants at the end of a period of at least 2 months in the lower jaw and 3 months in the upper jaw, no sign of infection and observation of no marked radiolucent areas around the implants in periapical radiographs.

Results

A total of 2005 patients were included in this study. Among those, 943 were females and 1062 were males. A total of 4552 implants were applied in 2005 patients. Among the implants, 1877 were RBM surface and the remaining 2675 had SLA surface (Table 1). Seventy-four out of 1877 RBM surface implants failed (%96.06). The success rate was 94.75 % and 97.22%, maxilla and mandible, respectively. Among the 1877 implants, 215 were applied in the anterior maxilla and 12 (94.42%) failed. Thirty-two of the 623 implants applied in the posterior part of the maxilla failed (%94.87). Seven out of 180 (%96.12) and 23 out of 859 (%97.33) implants in the anterior mandible and posterior mandible, respectively failed (Table 2).

Among the 2675 SLA surface implants, 93 failed (%96.53). The success rates were 95.29% and 97.11% in maxilla and mandible, respectively. Nineteen out of 290 implants applied in the anterior part of the maxilla failed (%93.45), while 30 out of 801 in the posterior maxilla failed (%96.26). In the anterior mandible, on the other hand, 19 out of 258 (%92.66) and 25 out of 1326 in the posterior mandible failed (%98.12) (Table 3).

Table 1. RBM and SLA surface implant numbers, failures and success rate

	Total	Fail	Success rate (%)
RBM surface implants	1877	74	96.06
SLA surface implants	2675	93	96.53

Table 2. RBM surface implant number, failures and success rates along the mandible and maxilla posterior and anterior groups

RBM	Anterior			Posterior		
	Total	Fail	Success Rate (%)	Total	Fail	%
Maxilla	215	12	94.42	623	32	94.87
Mandible	180	7	96.22	859	23	97.33

Table 3. Sla surface implant number, failures and success rates along the mandible and maxilla posterior and anterior groups

SLA	Anterior			Posterior		
	Total	Fail	Success Rate (%)	Total	Fail	Success Rate (%)
Maxila	290	19	93.45	801	30	96.26
Mandible	258	19	92.66	1326	25	98.12

Discussion

Continuous efforts such as the development of new surgical techniques, better bone graft materials, and improvement of implant design have been made in order to increase the implant success and decrease the healing time with the widespread use of implant application. It was reported in many studies that rough surface implants were more advantageous in bone healing compared to machine polished implants [7,8]. An increase in bone and implant contact area values is provided, since the contact area is increased in rough surfaces and this facilitates adhesion of osteoblasts to the implant surface and has positive effects on their proliferation [10,11].

Both acid etch [12] and media blasting [10] have demonstrated an increase in bone and implant contact areas and high degree osteoconductive property when applied to surfaces in histological studies. Cooper evaluated the effect of surface topography in dental implants on the surrounding bone and reported increased bone contact due to increased surface area and thus improved mechanical properties [13].

On the other hand, Davies pointed out the wetting capability of the surface in his hypothesis and reported that clot adherence around the implant provided a better osteointegration in rough surfaces [14].

Im et al. compared RBM and SLA surfaces in their study that was performed in the canine maxilla and reported good early stability values by periotest in implants with both surfaces. However, periotest performed in the 12th week resulted in higher stability values in RBM surfaces compared to SLA surfaces. No statistical difference was reported in torque values and bone and implant contact areas and bone area fraction occupied values between the groups. As a result, both SLA surface and RBM surface stability were demonstrated to be good and had good healing patterns compliant with the surrounding bone [15]. Also, higher bone and implant contact area values and osteoblastic activity have been observed in SLA surface and RBM surface implants compared to the machine treated implants in many previously published studies [12,16].

SLA, RBM and RBM acid etch surface implants were compared in a study by Coelho et al., and no difference was found in removal torque and implant bone interlocking values in spite of increased surface roughness of the SLA surface [17].

Buser et al. evaluated the association of bone and implant contact and tried implants with 6 different surfaces in the long bones of miniature minipigs. They found a direct proportion between increased surface areas and implant-bone contact. The highest bone implant contact area was found on the roughest surface at the end of the 6th month [18]. Wennerberg et al. compared two different blast surfaces and found that surface with increased roughness provided a better bone fixation and a serious rate of removal torque value, and increased implant contact area [19].

In a 5-year study performed using IMZ implants, the success rate of cylindrical implants roughened with titanium plasma was reported to be 95.8 % and 92.9% in mandible and maxilla, respectively [20]. Babbush and Shimura demonstrated a mean of 95.0% percent success rate in a 5-year clinical study with IMZ implants. The success rate was 96.0% in both partially and totally toothless patients and 92.0% and 99.0% in maxilla and mandible, respectively. The main factors positively affecting the success were reported to be the use of the longest and the widest diameter implants compatible with the clinical condition [21]. Some authors declerated that the widest and longest implants positively support primer stability and also osteontegration [22]. However, there are studies indicating that implant diameter and length have no effect on osteointegration [23]. Bischof et al. researched the factors related to osteointegration. They reported that the implant diameter, length, implant design do not influence the osteointegration, on the other hand, only the bone type of the jaws was found the primer factor for osteointegration [24].

The reported success rate of 95.3% that was achieved with SLA surface solid screw implants in the 5-year ITI follow-up report is similar to the implant success rate of the Branemark system [25]. Similarly, success rates of 94.36% and 97.22% were seen in maxilla and mandible, respectively, in RBM surface implants and 97.22% and 97.33% in mandible and maxilla, respectively, in the SLA surface implants in this present study. Both surfaces were found to be successful at similar rates and were found to be safe.

Conclusion

Consequently, RBM and SLA surface implants with the same trademark and same design were clinically compared, and no significant difference was found between them in terms of osteointegration success. Both RBM and SLA surfaces were found to be safely preferable with proper case selection, appropriate surgical technique, and patient motivation

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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