Implant Surface Treatments: A Literature Review

The clinical success of dental implants is dependent on successful osseointegration. An important parameter for achieving osseointegration is the establishment of direct contact between the surface of the implant and the surrounding bone. There have been numerous studies indicating that implant surface roughness affects the rate of osseointegration.1,2

A variety of endosseous dental implants with unique topographies are commercially available. Dental implant manufacturers have modified implant surfaces through mechanical, chemical, electrochemical and laser treatments in their efforts to create implants that promote accelerated healing and osseointegration (Fig. 1). For example, the resorbable blast media (RBM) surface treatment technique utilizes calcium phosphate, a biocompatible material, to increase the surface area of implants and provide greater bone-to-implant contact. RBM-treated materials are also osteoconductive and thus encourage the growth of cells. RBM treatment creates an extremely clean implant surface that does not inhibit the gathering of osteoblast precursor cells. Furthermore, the hydrophilic surface of RBM-treated implants draws the blood, and the cells carried in the blood, to the surface quickly. This is advantageous and supports successful implant therapy because the cells initiate bone development on the implant.3,4

In this literature review, a number of long-term prospective and retrospective studies were critically assessed in order to evaluate the clinical performance of a variety of dental implants, along with their respective surface treatments. The studies utilized for review reported and analyzed success and survival rates, and were published within the past 11 years.

<table>
<thead>
<tr>
<th>SURFACE TREATMENT</th>
<th>IMPLANT SYSTEM/SURFACE</th>
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<tr>
<td>Acid-etched</td>
<td>BIOMET 3i OSSEOTITE® and NanoTite™</td>
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<tr>
<td>Etching with strong acids increases the surface roughness and the surface area of titanium implants.</td>
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<tr>
<td>Anodized</td>
<td>Nobel Biocare TiUnite®</td>
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<tr>
<td>This electrochemical process thickens and roughens the titanium oxide layer on the surface of implants.</td>
<td></td>
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<tr>
<td>Blasted</td>
<td>DENTSPLY Implants Astra Tech TiOblast®, Zimmer Dental MTX®, Inclusive® Tapered Implants</td>
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<td>Particles are projected through a nozzle at a high velocity onto the implant. Various materials, such as titanium dioxide, aluminum dioxide and hydroxyapatite (HA) are often used. HA treatments also include microtextured (MTX) surface treatments and RBM surface treatments (Figs. 2a, 2b).</td>
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<tr>
<td>Blasted and acid-washed/etched</td>
<td>CAMLOG Promote®, DENTSPLY Implants Frialit® and Friadent® plus, Straumann® SLA®</td>
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<tr>
<td>Implants undergo a blasting process. Afterward, the surface is either washed with non-etching acid oretched with strong acids.</td>
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<tr>
<td>Hydroxyapatite (HA)</td>
<td>Implant Direct [various], Zimmer Dental MP-1®</td>
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<tr>
<td>HA is an osteoconductive material that has the ability to form a strong bond between the bone and the implant.</td>
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<tr>
<td>Laser ablation</td>
<td>BioHorizons® Laser-Lok®</td>
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<td>High-intensity pulses of a laser beam strike a protective layer that coats the metallic surface. As a result, implants demonstrate a honeycomb pattern with small pores.</td>
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<tr>
<td>Plasma-sprayed</td>
<td>Straumann® ITI® titanium plasma-sprayed (TPS)</td>
</tr>
<tr>
<td>Powdery forms of titanium are injected into a plasma torch at elevated temperatures.</td>
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Figure 1: Overview of implants and their respective surface treatments.5,6
Prospective Clinical Studies

A nine-year longitudinal study included 2,132 implants placed in 731 patients. In this study, 1,374 MTX screw-type implants and 758 HA-coated implants were placed. At the end of nine years, the authors reported a cumulative survival rate of 97.9 percent.7

Another study included 386 HA-coated implants and 234 RBM external hex implants over a period of six years. The survival rate for the implants was 96.6 percent and 95 percent, respectively.8

One study monitored the survival rate of 550 RBM implants placed in 155 patients. The implants were placed following either one- or two-stage protocols in the control group. Implants were immediately loaded in the test group. The cumulative survival rate was 100 percent for the control group, and 98.8 percent for the test group at five-year follow-up. There was no statistically significant difference in the survival rates of implants in the two groups.9

In another study, 60 patients with potentially compromising clinical factors were treated with 218 MTX implants. Four out of 218 implants failed. The study revealed a cumulative survival rate of 98.2 percent after five years, with most reports of failure detected after the first year.10

In a study by Akoglu et al., three different implant systems were studied including 24 abrasive-blasted, acid-etched implants, 24 RBM implants, and 24 titanium-dioxide-textured implants. The cumulative survival rate was 100 percent after five years of loading. Marginal bone loss was within the clinically acceptable range for all groups.11

A four-year clinical study observed 1,077 RBM implants in 348 patients. Reported success rates were 99.3 percent in mandibles and 100 percent in maxillae.12

Retrospective Clinical Studies

A single clinician placed 173 RBM implants in 46 patients. A retrospective clinical evaluation after a 10-year duration reported a success rate of 97 percent.13 Another retrospective study on RBM implants looked at survival rates after 10 years. The study indicated a 100 percent survival rate for immediately loaded implants and 98.11 percent for the delayed-loading group. One implant had failed in this group, but the authors concluded that there was no significant difference in long-term results between the groups.14

One retrospective study examined different implant surfaces for a 10-year duration. Titanium-dioxide-blasted, RBM, abrasive-blasted and acid-etched, MTX, HA, and anodized implants were used. There were significant differences in the cases studied, including patient age, prosthesis type, and the design, surface, length and location of the implant. There were no significant differences in relation to patient gender, implant diameter or bone quality. The authors concluded that patient age, prosthesis type, and implant design, length and location had a significant effect on implant survival rate. Nonetheless, the cumulative survival rate for the implants studied was 96.33 percent.15

In another study, 30 periodontally susceptible subjects with 138 MTX implants and 16 control subjects with 35 MTX implants were followed up annually for 10 years. Implants were placed in the periodontally susceptible subjects using an osteocompressive surgical technique, while the manufacturer’s protocol was followed to place implants in the control subjects. Cumulative survival rate was 99.3 percent.
in periodontally susceptible subjects and 100 percent in the control group.16

In an eight-year retrospective study, 60 patients were treated with 267 MTX implants. Four implants failed, resulting in a cumulative survival rate of 98.5 percent. Bone loss greater than 1.5 mm was observed in 1 percent of the cases studied.17

Another study evaluated four different types of implants after five years of function. Three of the implant systems studied featured abrasive-blasted, acid-etched surfaces, while the fourth featured an RBM surface. The implants were placed in 83 patients. After five years, all implant systems had similar clinical success and survival rates.18

Summary

The studies reviewed report survival rates from 93.09 to 100 percent. Several review articles also suggest that regardless of surface treatments, most implants on the market are comparable to each other.19-22 There is no clear indication that dental implants with a specific morphological characteristic provide any benefits over implants with a different structure. Very minor differences exist in the performance of various implant surface types.23,24 Ongoing efforts in the development of surface technology are aimed at enhancing tissue-surface interactions and healing response, with the ultimate goal of improving patient care.1M

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REFERENCES


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