CASE REPORT

http://dx.doi.org/10.5125/jkaoms.2016.42.1.38
pISSN 2234-7550 · eISSN 2234-5930

Histologic analysis of resorbable blasting media surface implants retrieved from humans: a report of two cases

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Abstract (J Korean Assoc Oral Maxillofac Surg 2016;42:38-42)

The purpose of this study is to evaluate the degree of osseointegration of resorbable blasting media (RBM) surface implants retrieved from humans. Three implants in the mandibular molar region that were surface-treated with RBM were retrieved from two patients. The implants were used to manufacture specimens in order to measure the bone-implant contact (BIC) ratio. The BIC ratios of the three implants were found to be an average of 69.0%±9.1%. In conclusion, that RBM surface implants are integrated into the host environment with histological significance and the BIC ratio of the RBM surface-treated implant was not significantly different from that of other surface-treated implants.

Key words: Dental implants, Removal

[paper submitted 2015. 3. 26 / revised 2015. 4. 21 / accepted 2015. 5. 3]

I. Introduction

There are many factors that contribute to the success of an implant. Characteristics of the implant surface include the topographical characteristics of the surface, thickness of the titanium oxide layer, porosity of the surface, and chemical composition of the surface. Surface treatment is known to stabilize blood clot formation, increase fibrin attachment, and promote migration and differentiation of cells, which influences bone formation at early stages[1,2].

There have been many studies on the surface treatment of an implant. However, evaluation of various methods is still ongoing in an effort to establish the optimal surface treatment. Most of the studies to date that have been conducted on implant surface treatments are based on cell or animal experiments. Furthermore, there has been little work with regard to the analysis of the bone-implant contact (BIC) ratio, which is closely related to the implant surface treatment method.

The purpose of this study was to analyze the BIC ratio of a resorbable blasting media (RBM) surface-treated implant retrieved from humans, and to compare this with the BIC ratio of implants using other surface treatment methods.

II. Cases Report

1. Case 1

A 78-year-old female patient visited the hospital complaining about gingival pain and swelling in an implant of the left mandibular molar region. The implant was placed in a dental clinic six years before. A radiograph that showed the RBM surface of the implant (Osstem, Busan, Korea) was obtained, and crestal bone loss was observed.(Fig. 1) The dental prosthesis in the coronal portion of the implant was removed, and her progress had been observed for one year. The patient continued to complain of discomfort and asked for removal of the implant. A trephine bur was used to remove implants #36 and #37. The resulting bone defect was resolved with Bio-Oss (Geistlich Pharma AG, Wolhusen, Switzerland) before

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being covered with Bio-Gide (Geistlich Pharma AG).

2. Case 2

A 46-year-old male patient visited the hospital, complaining that the screw of implant fixture #46 had loosened after the implant was placed in a dental clinic one year previously. According to the examination, the RBM surface of the implant (Osstem) was found to be slanted toward the center of a circle, while the implant platform had lost its original form. Therefore, restoration was considered impossible, and prosthodontic treatment was the only option.(Fig. 2) A trephine bur was used to remove the implant, and the material ExFuse (Hanmi Inc., Seoul, Korea) was used for the bone graft; Bio-Gide (Geistlich Pharma AG) was then used for coverage. After 18 months, an implant was placed again.

3. Specimen processing and measurement of BIC ratio

Immediately after the implant was removed, it was placed into 10% formalin solution for fixation, soaked in 70% alcohol for further fixation for six days, and then washed in running water for 24 hours. For dehydration, implants were soaked with alcohol for a single moment. Next, the implant was embedded with a glycomethacrylate resin (Spurr Low-Viscosity Embedding Media, Polyscience, PA, USA) and polished to a thickness of approximately 200 μm, parallel to the major axis of implant, which was to the manufacturer's specifications. After Villanueva osteochrome bone stain (SBT, Sans Clemente, CA, USA) was performed, an optical microscope (Olympus BX51; Olympus, Tokyo, Japan) was used to analyze the BIC ratio of the two specimens that were manufactured for each implant. Six specimens were manu-

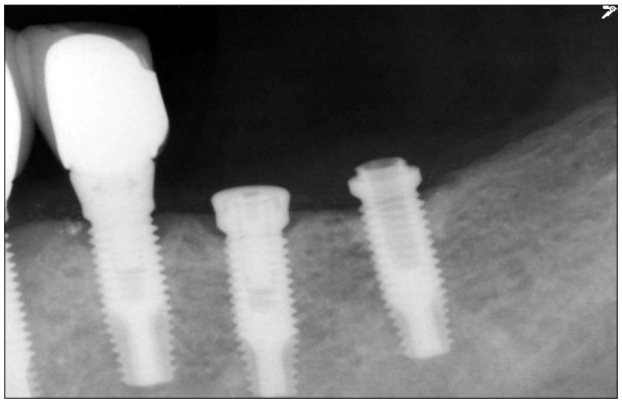

Fig. 1. Bone resorption progressed from upper first thread of #36 implant and second thread of #37 implant.
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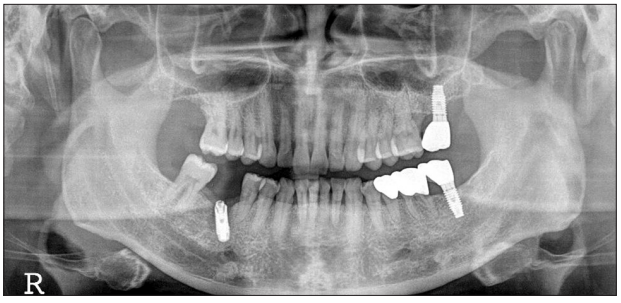

Fig. 2. Malposed implant was observed. Implant prosthesis was retrieved.
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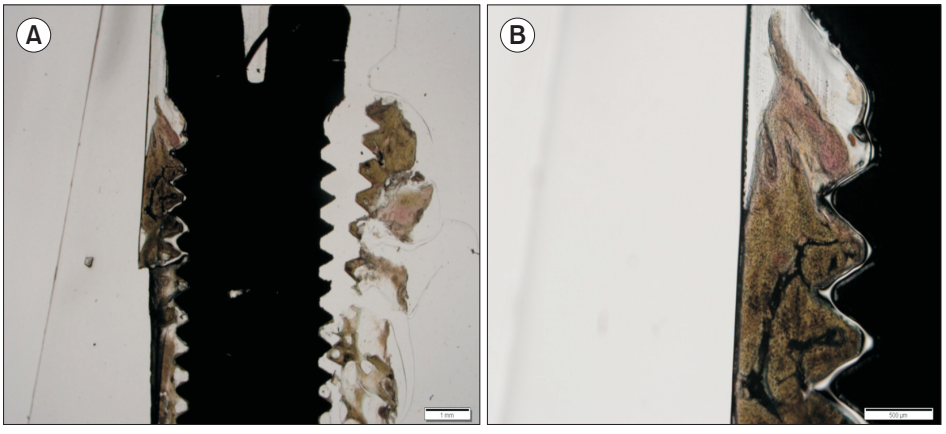

Fig. 3. A. Overview of a histological section obtained from the retrieved implant. No resorption of the coronal bone is present and no infrabony pockets are present (Villanueva osteochrome bone staining, ×12.5). B. Newly formed bone can be observed around the implant. The dark line is due to trabeculae of newly formed bone. Gaps around the implant are defects created during specimen production (Villanueva osteochrome bone stain, ×40).
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factured in total. The BIC ratio was calculated from the highest point of remaining bone using the following equation.

BIC ratio (%)=(length of bone in contact with implant surface/total length of implant surface)×100

1) Case 1

Ring-shaped bone loss was observed surrounding implant #36. However, the first screw line of the implant was not exposed. In several parts, the implant was found to be separated from bone, which seemed to be a defect created during specimen manufacturing. Interposition of connective tissue was not found between implant and bone, and it was observed that a solid bone with a small medullary cavity was formed. The BIC ratio measured in the two specimens was 78% and 75%, respectively.(Fig. 3)

Bone resorption of implant #37 was in progress up to the second screw line, and a degree of bone resorption was found in the specimen. Bone separation was found on both sides of the specimen, which was attributable to a defect in the process of manufacturing. It was found that bone formed well between screw lines. The BIC ratio measured in the two specimens was 70% and 71%, respectively.(Fig. 4)

2) Case 2

A significant bone loss was found in implant #46, due to an inappropriate occlusal force. The defect created when the implant was removed led to the specimen in which the implant was observed to be separated from bone. New bone was formed densely between screw lines, and the BIC ratio measured in the two specimens was 52% and 68%, respectively. (Table 1, Fig. 5)

III. Discussion

There has been many studieds on the surface treatment of an implant. Sandblasted with large grit and acid etching (SLA) surface treatment method consists of acid etching after media blasting. The method is to create uniform roughness and increase surface porosity, which reduces the time to bone integration[3]. Such a porous structure is known to be formed layer by layer with a thickness of 1 to 100 μm. Many researches measured the BIC ratio of an implant that was treated with SLA. The BIC ratio ranged from 54.7% to 87.5%[4-6].

Surface treatment with hydroxyapatite (HA) is known to reduce the time to bone integration because of its biocompatibility. HA has a high binding force between serum protein and growth factor and thus can promote attachment and proliferation of osteoblasts. As a result, HA reduces loading time in sections with poor bone quality[7,8].

Brunel et al.[9] reported that the BIC ratio of HA-coated implant was 74%. In most of the cases, the HA-coated implant was placed in the maxillary molar region. The BIC ratio ranged from 54.2% to 99.8% and exhibited excellent results in general[4,9,10].

Anodic oxidation coating enables the ability to increase the thickness of the titanium oxide layer and maintain ions on the surface. When the anodic oxidation coating is used, it is possible to increase the thickness of the titanium oxide

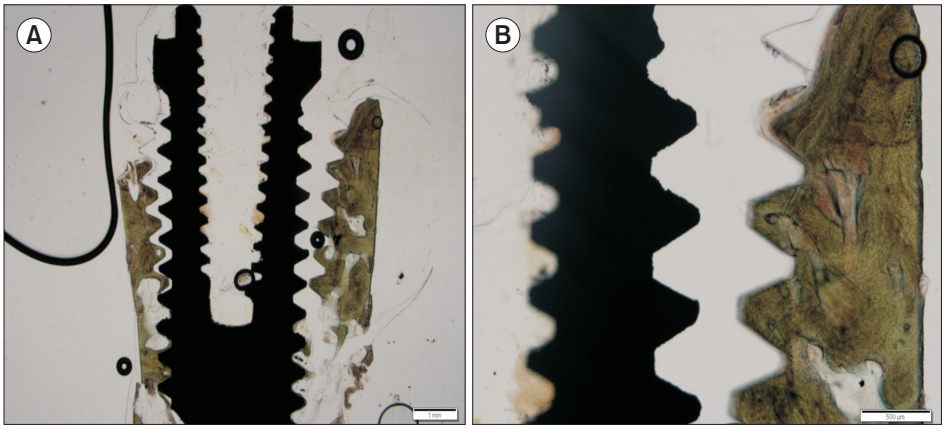

Fig. 4. A. Overview of a histologic section obtained from the retrieved implant. Bone resorption can be observed around the implant. Whitish artifact is due to trabeculae of newly formed bone. Gaps around the implant are defects created during specimen production (Villanueva osteochrome bone staining, ×12.5). B. Newly formed bone and pre-existing bone can be observed around the implant. The grayish/whitish translucent area on the right side is an artifact created by trabeculae of newly formed bone (Villanueva osteochrome bone staining, ×40).

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Table 1. Retrieved implant data

Patient No.	Age (yr)/gender	Area	Implant surface topography	Loading time (mo)	Cause for removal	BIC ratio (%)
1	78/female	#36	RBM	60	Psychological	78, 75
		#37	RBM	60	Psychological	70, 71
2	46/male	#46	RBM	13	Malposition	52, 68

(RBM: resorbable blasting media, BIC: bone-implant contact)
BIC ratio was measured on each slice.
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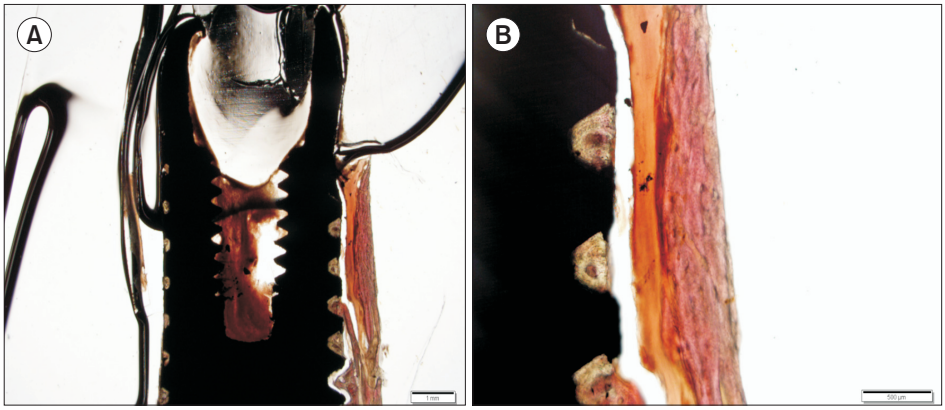

Fig. 5. A. At low magnification, loose contact between the implant and bone can be observed. There are gaps and fibrous tissue at the implant-bone interface (Villanueva osteochrome bone staining, ×12.5). B. At higher magnification, newly formed bone can be observed between fixture threads. Farthest to the right, the red-stained area indicates newly formed bone. The orange-stained area between the fixture and newly formed bone indicates connective tissue (Villanueva osteochrome bone staining, ×40).
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layer from 1,000 nm up to 5,000 nm and incorporate active ions of Mg, Ca, and P on the surface of the titanium oxide layer. It has been known that the reaction of positive ions can promote aggregation and attachment of initial protein and ligand-mediated reaction[11,12]. TiUnite (NobelBiocare, Göteborg, Sweden) implant is a typical P-incorporated implant. In particular, Sul[11] reported that the BIC ratio of implants incorporated with calcium and phosphorus ions increased by 2.7 times and 2.3 times, respectively, compared to those of the existing machined implant. Especially, Rocci et al.[13] reported that the BIC ratio of anodized surface implants ranged from 67.1% to 95.5% on posterior mandibular area.

Dual-acid etched method is used to surface-treat an implant with two or more mixed methods or to surface-treat implants using complex methods separately for upper and lower components. A typical implant is OSSEOTITE (BIOMET 3i Implant Innovations, Palm Beach Gardens, FL, USA) that is treated with acid. Davies[14] reported that the OSSEOTITE surface treatment technique could reduce the healing period to eight weeks. In addition, that report showed that the technique enabled fibrin to attach well to the surface of the implant, which stabilized the blood clot and helped resist micromovement of the implant. Three articles were researched, and five OSSEOTITE implants from three persons were found. The BIC ratio for these implants ranged from 48.6% to 81.5%[15-17].

On the RBM surface, bone-compatible material was used as blasting media for etching the implant, which increased the surface area and BIC ratio strength. Recently, many surface treatment methods have emerged that are sub-categorized according to the particle component used for RBM surface treatment, roughness, condition of processing temperature, and post-processing.

According to studies on stability of implants, there is a high correlation between implant removal torque values and the BIC ratio, and between the BIC ratio and resonance frequency analysis value[3,18,19]. Kim et al.[19] conducted a study on the stability of an implant that was treated with RBM and placed in the maxillary molar region. These researchers reported that the implant stability quotient was 63.6 for implant placement and 74.4 for the second surgery. These researchers also reported that no significant alveolar bone resorption was found, indicating excellent clinical results.

In this study, the BIC ratio of RBM-treated implants retrieved from humans was 69.0%±9.1% on average, which was similar to the range for SLA or HA coating. Although

the second case report showed that bone resorption in the surroundings of the implant was relatively high, the bone resorption was believed to be attributable to traumatic occlusion, rather than to inflammation in the surroundings of the implant.

As changes have been made in the content of calcium and phosphorus and the blasting method of the RBM implant, many comparative studies have been conducted recently. The study of the characteristics of the implant surface has immense potential and could be used to expedite development of implants in the future. However, most studies have been conducted *in vivo* or *in vitro*. Therefore, it has been impossible to confirm successful results from a histological perspective, which is a major limitation of studies conducted to date. Consequently, it is necessary to verify study results with clinical data that are collected over an extended time period.

In conclusion, even though the number of implants examined in this study was small, it was clear that RBM surface-treated implants placed in humans do not show a large difference in BIC ratio compared to other surface-treated implants. It was also found that bone was integrated with the implants with histological significance.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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